IEEE SOCIETY ON MICROWAVE THEORY AND TECHNIQUES

NEWSLETTER

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M/A-COM, Inc., South Avenue, Burlington, MA 01803

Number 118 Spring 1987

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EDITOR'S NOTES

by Peter W. Staecker

Microwave Statisticians

This issue contains no fewer than three reports of membership growth within our Society in the past year, each citing different numbers, but all leading to the same conclusion: we are getting bigger...faster.

A potential trap for the unwary is the year-end membership slump, a periodic negative-going spike in our growth curve (see the figure on page 54) caused by the forgetful, disenchanted, or career-changing component of our Society. Al Estes, our Membership Development Officer, has promised to explain this effect in full detail in a later issue.

Your faithful neophyte editor, unaware of the year-end glitch, had been planning for a print run of 9000 for the Winter Newsletter (press run: mid-January). The December membership number of 9445, trumpeted loudly at the January 14 AdCom meeting, sent him scrambling to the printer for an additional 500 copies. Imagine his surprise when only 9000 mailing labels arrived from IEEE.

Requests for additional issues of #117 will be honored while supplies last.

Special Articles

This issue features a number of guest authors, presented for your education and entertainment. Hank Paczkowski and Jim Whelehan have collaborated to write the first of a two-part primer on noise, and Ed Miller (AP) is sharing his column on PCs with our Society for the first time. Cheryl Reimold contributes some unique thoughts on writing techniques in the first of a number of interesting articles from this communications professional. Finally, for those of you who missed his article in **Spectrum** a few years ago, Bob Lucky's insights into the editorial review process are reprinted for your enlightenment.

Steve March has planned a great time for us all in Las Vegas in June. See you there.

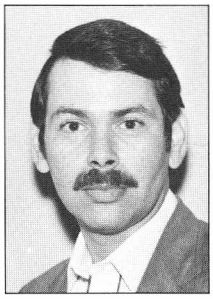
MTT-S NEWSLETTER COPY DEADLINE INFORMATION

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

* For special technical articles, submit 8 weeks earlier.

THE 1987 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM

Las Vegas, Nevada
June 9-11



by Steven L. March
Symposium Steering Committee Chairman

On behalf of the Symposium Steering Committee, it gives me great pleasure to invite you to attend the 1987 IEEE MTT-S International Microwave Symposium. This year, the Symposium and the other activities which comprise **Microwave Week** will be held, for the first time, in Las Vegas.

Hotels

This year's Symposium will be held at Bally's Grand Hotel, one of the largest hotels in the world and one which has sufficient space and facilities to accommodate a meeting as large as ours. The technical sessions, the workshops, the panel sessions, the MTT-S Historical Exhibit, and the commercial exhibition will all take place under one roof. In order to accommodate the expected record number of technical attendees, exhibitors and guests who will be participating in Microwave Week, we have arranged for hotel rooms at three additional properties, nearly monopolizing the intersection of Flamingo Road and Las Vegas Boulevard, the heart of the famous Las Vegas "Strip." Our block of 2,500 rooms at $75 per night at the Bally's Grand Hotel is augmented by 1,100 rooms at Caesars Palace and 500 rooms at the Flamingo Hilton, both of which have room rates of $65 per night. For attendees on a limited budget, such as Government employees or those on a university per diem, there are 400 rooms at the Dunes for $50 per night. Note that all rates are for either single or double occupancy and are exclusive of the 7% Clark County room tax.

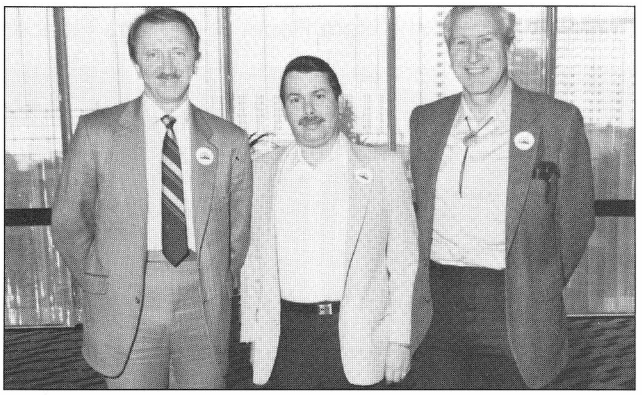
Schedule of Events

Microwave Week activities begin Sunday evening, June 7th, with a reception for the attendees of the 1987 IEEE Microwave and Millimeter-Wave Monolithic Circuits Symposium. This event will be held in the ornate and spacious Nero Room in Caesars Palace. Technical sessions for the MMIC Symposium will be held Monday and Tuesday. The second day's sessions will be joint with the International Microwave Symposium. In order to accommodate twenty MMIC Symposium

(continued on page 3)

1987 Symposium (continued from page 2)

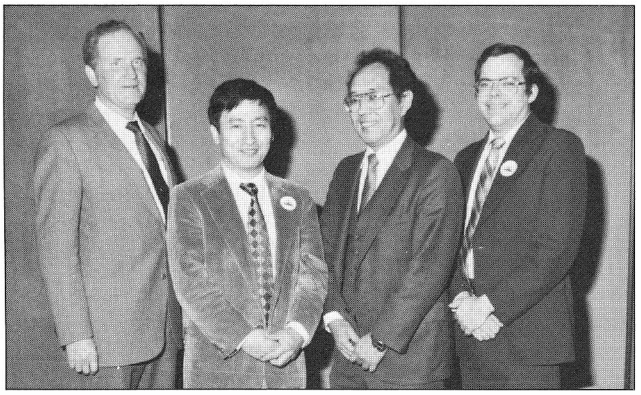
presentations on Monday, the Monolithic Circuits Symposium will, for the first time, be having parallel sessions in the afternoon.



Les Besser, Steven L. March, Alvin Clavin.

Opening Session

We will be holding a conventional opening session on Tuesday morning. After welcoming remarks from the Symposium General Chairman and the Technical Program Committee Chairman, we will hear brief addresses from IEEE President Henry Bachman and MTT Society President David M. McQuiddy, Jr. This year's Keynote Address will be presented by Les Besser, President of Besser Associates and Microwave Educational Programs and Vice Chairman of the Symposium. In his speech, he will address the evolution of the microwave engineer from the 1930s to the 1990s. The ceremonies will conclude with brief remarks from representatives from the Office of the Governor of the State of Nevada and from the Office of the Mayor of the City of Las Vegas. It should prove very enlightening.



John B. Horton, Tatsuo Itoh, Reynold S. Kagiwada, James C. Rautio.

Technical Program

The technical program for the International Symposium contains a record 222 papers, which will be presented in three parallel sessions on each of the three days of the Symposium. The Technical Program Committee under the direction of Dr. Reynold S. Kagiwada selected only the best papers from the record number of submissions (400) this year. Their efforts have resulted in a technical program of the highest quality.

Open Forum Sessions, first introduced as part of the MTT Symposium in 1983, will again form an integral component of the technical program. These sessions have become very popular since they afford both the authors and the participants time for in-depth discussions of presentations. For the convenience of the attendees, Open Forum papers will be grouped by technological classification. Refreshments will be served in the Open Forum Sessions.

Because of strong and continued interest in the technologies, *Optical Techniques for Microwave Applications* and *Millimeter-Wave Techniques* will be addressed in Focused Sessions, containing invited and contributed presentations. Each area will have two sessions, four papers per session. We will again be holding a European Exchange Session, featuring three renowned European scientists. In total, there will be thirty-two technical sessions encompassing the entire scope of "Microwave Theory and Techniques" from to A to Z.

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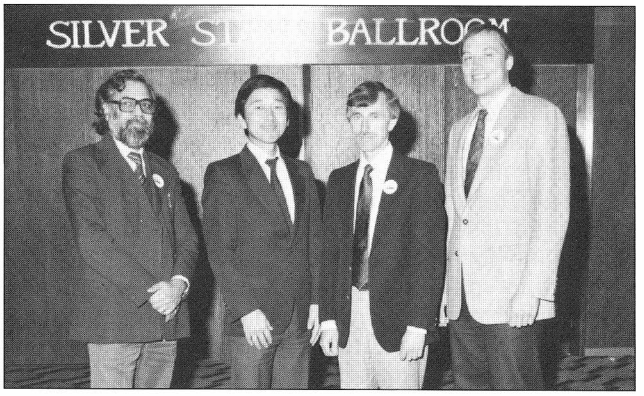
John M. Owens, Karl R. Varian, Gail E. March, Ronald L. Carter, John W. Wassel, Krishna K. Agarwal.



Vijai K. Tripathi, H. John Kuno, Jeffrey B. Knorr, Mark Roos.

Missing from Symposium Steering Committee photos: Carol Gentile, Nance Cohen, Darlene Payette, Arvind K. Sharma, David Leiss, Arye Rosen, Richard V. Snyder, Long Q. Bui, Philip T. Chen, A.P.S. Khanna, George Szentirmai, George Jerinic, Harlan Howe, Jr., Howard I. Ellowitz, Rolf H. Jansen, Andre VanderVorst, Barry E. Spielman.

1987 Symposium (continued from page 3)

Special Sessions

In addition to the regular sessions, our TPC Special Sessions Vice-Chairman, Dr. Tatsuo Itoh, has arranged eight specialist workshops and four panel sessions to round out the technical content of the Microwave Symposium. The Monday workshops will all be held from 8:30 a.m. to 5:00 p.m. Those organized for Monday include *Numerical Techniques for Microwave Field Problems and Their Implementation on Personal Computers, Amplification in High Power Systems,* and *Non-Invasive Microwave Sensing of Physiological Signatures.*

Two of the five workshops scheduled for Friday, June 12th, are designed to augment the Focused Sessions. These are *Quasi-Planar Millimeter-Wave Components and Subsystems* and *Optical Microwave Interactions.* The other three Friday workshops are *Nonlinear Microwave Computer-Aided Design and Associated Modeling, Planning the Packaging for the Next Generation of Integrated Circuits,* and *Dielectric Resonator Oscillators.* All workshops include lunch and are full-day (8:30 am-5:00 pm) sessions.

Ulrich L. Rohde, Ferdo Ivanek, Robert Weck, Robert L. Eisenhart.

Panel sessions provide the setting for the exchange of information between expert panelists and the Symposium's technical participants. These sessions are scheduled for lunch time and reasonably-priced box lunches will be available for those wishing to attend these informative discussions. *Financial Planning for the Engineer: The Impact of the New Tax Law* is the PACE-sponsored discussion scheduled for Tuesday noon. Competing for your attention on Tuesday will be a stimulating panel session on *GaAs Microwave Monolithic Integrated Circuits*, which is planned to augment the Monolithic Circuits Symposium which concludes that day. Wednesday noon offers a comprehensive discussion on *Applications on HEMT Devices and Circuits.* Our fourth panel session, *Problems in Primary and Continuing Microwave Engineering Education,* scheduled for lunch time on Thursday, has been organized by our Vice Chairman, Les Besser.

ARFTG Conference

On Friday and Saturday morning, the 29th Automatic RF Techniques Group Conference will be held to advance the art of microwave measurements and computer-aided technology. The theme for this year's ARFTG gathering is **Noise Parameter Characterization**. The Conference is chaired by Peter Lacy of Wiltron Corporation. The ARFTG Banquet will be held Friday evening in the Nero Room at Caesars Palace.

Ronald E. Ham, Stephen F. Adam, Yalcin Ayasli, Margaret Whicker, Lawrence R. Whicker, Clifford M. Krowne.

Continental Breakfast

To make it convenient for you, complimentary continental breakfasts will be served from 7:30 a.m. to 8:30 a.m. every morning, Monday through Friday, for technical registrants. The Gable Ballroom Foyer will be used for continental breakfasts on all days and will be augmented by the Metro Foyer on Friday morning.

Historical Exhibit

The MTT-S Historical Exhibit will be located in the Rialto 2, 3 and 4 rooms, located in a place of prominence between the Goldwyn Ballroom and the Grand Ballroom, the vast location for the Commercial Exhibition. Hardware, artifacts, books and other memorabilia will be on display during the three days of the International Microwave Symposium. Films of microwave historical importance will be shown in a comfortable theatre setting, complete with fresh popcorn and liquid refreshments.

Exhibition

As in the past, *Horizon House — Microwave, Inc.* will be managing the Commercial Exhibition. With over 250 companies occupying more than 425 booths, the Commercial Exhibition has again achieved a record size. With the Commercial Exhibition occupying both the Grand Ballroom and the Goldwyn Ballroom, remember to reserve enough time to visit with the exhibitors and to view their latest technological achievements and the state-of-the-art in microwave hardware and software.

Feel free to purchase an extra Symposium Digest and collect all of the information that you want from the commercial exhibition. You will be able to ship it all home via United Parcel Service (UPS) at a nominal

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1987 Symposium (continued from page 4)

cost. UPS will provide packing material, boxes, labels, etc. and will be present at the Symposium on Wednesday afternoon, all day Thursday, and on Friday morning.

Guest Program

If you are bringing guests (and we hope that you are), we have scheduled a complete daytime program of exciting tours including a visit to the world-famous Hoover Dam, one of the seven man-made wonders of the world. Other locations that our guests will have the opportunity to visit include the Liberace Museum, the scenic Red Rock Canyon area, the Ethel M. Chocolate Factory and Cactus Garden, and backstage at one of Las Vegas' fabulous revue shows. Children aged 12 and under are invited to participate in these activities for a nominal charge of $5.00 per child per tour.

A Guest Hospitality Suite will be located in the Metro 4 room on the 26th floor of Bally's Grand Hotel. The suite will be open from 7:30 a.m. to 5:00 p.m. from Monday through Friday and will be serving complimentary continental breakfast in the morning and finger sandwiches, snacks and liquid refreshments in the afternoon. Hostesses will be on duty to assist you and your guests with your arrangements and needs during your stay in Las Vegas.

Reception/Cocktail Party

The *Microwave Journal* cordially invites all International Microwave Symposium registrants, Monolithic Circuit Symposium and ARFTG Conference attendees, exhibit personnel and their guests to a reception on Monday, June 8th from 6:00 p.m. to 8:00 p.m. poolside at Caesars Palace, located diagonally across the street from the Symposium Headquarters. Wine and hors d'oeuvres will be served.

The 1987 Industry-Hosted Cocktail Party will be held on Wednesday, June 10th, from 5:45 p.m. until 7:15 p.m. in the Gable Ballroom area on the second floor of the tracy Tower in Bally's Grand Hotel. MTT-S Symposium and Monolithic Circuits Symposium registrants will each receive two complimentary beverage tickets in their registration packages, which will be honored during this reception. Additional beverage tickets may be purchased during the reception. Complimentary hors d'oeuvres will be served.

Awards Banquet

The social highlight of the 1987 International Microwave Symposium will be the Annual Awards Banquet on Wednesday evening immediately following the industry-sponsored cocktail reception. The Garland Ballroom on the third floor of the Tracy Tower serves as the lavish setting for the gourmet dinner and the awards presentation.

Awards will be presented to recognize accomplishments of some of the outstanding contributors to our Society and to our industry. The Microwave Career Award is the highest award given by the Microwave Theory and Techniques Society. This year's recipient is Dr. Robert W. Beatty, who has been granted the award "for a career of meritorious achievement and outstanding technical contribution in the field of microwave theory and techniques."

The Distinguished Service Award was established by the MTT Society in 1983 in order to properly honor those individuals whose service to the IEEE and to MTT-S has been extraordinary. For 1987, the Administrative Committee of the Microwave Theory and Techniques Society has selected Dr. Kiyo Tomiyasu as the recipient of the 1987 Distinguished Service Award "for his outstanding and dedicated service for the benefit and advancement of the Microwave Theory and Techniques Society." By the way, Dr. Tomiyasu was born in Las Vegas.

The Microwave Prize is awarded to the author(s) of that paper published in any official IEEE publication which is judged to be the most significant contribution in the field of interest of the Society. The 1987 recipient of the Microwave Prize is Dr. Christen Rauscher, whose winning paper, *Microwave Active Filters Based on Transversal and Recursive Principles,* was published in the December 1985 issue of the **IEEE Transactions on Microwave Theory and Techniques.**

Twenty-two members of the MTT Society were elected to the grade of Fellow of the IEEE as of January 1, 1987. It will be our great pleasure to present Fellow Awards at the Awards Banquet to Ali E. Atia, Donald M. Bolle and Albert E. Williams.

FELLOW LIST ADDENDA

The 1987 MTT-S Fellow list printed in the Winter 1987 MTT-S Newsletter (pg. 11) did not include the newly-elected Fellows. The following newly-elected Fellows are MTT-S members:

Evaluated by MTT

A.E. Atia
F.E. Gardiol
K. Miyauchi
A.A.M. Saleh
C.B. Swan
A.E. Williams

Evaluated by Indicated Soceity

N.G. Alexopoulos (AP)
J.R. Ashley (IM)
K.G. Balmain (AP)
D.M. Bloom (LEO)
D.M. Bolle (OE)
E.C. DuFort (AP)
E.S. Gillespie (AP)
E.J. Glenner (COMM)
D.T. Hodges (LEO)
C.M. Knop (AP)
H.J. Liebe (AP)
T. Sekiguchi (AP)
L-C. Shen (AP)
P.I. Somlo (IM)
D.R. Wilton (AP)

The entertainment scheduled for the Awards Banquet will be an exciting climax to a wonderful evening. Appearing for your enjoyment will be Harry Anderson — comedian, magician and star of the highly-popular television series, *Night Court.* The entertainment will be

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unforgettable. Since ticket sales are limited, be sure to reserve your seating as early as possible to avoid being disappointed.

Students at MTT

We are cultivating students to pursue a career in microwave engineering by assisting those students, who will be presenting papers, to attend the Microwave Symposium. By making your travel arrangements for discounted fares through either of our two "official carriers," PSA and American Airlines, you will be assisting us in this effort. The airlines will provide one free round-trip ticket to the Symposium for every 50 round-trips booked on that airline. For American Airlines, call the Meeting Services Desk at (800) 433-1790 and mention STAR File S-71668. Discounted fares from PSA are available through your travel agent or directly with PSA at (800) 435-9779. Reference SMILE number MC489S. Your assistance is greatly appreciated.

This Symposium is the culmination of many long hours of diligent work by the forty-plus members of the Steering Committee. Because of their dedication and professionalism, we have put together a truly great Symposium. Due to their efforts, this will be a successful and rewarding Symposium and one which will be remembered for many years to come.

With the entire Symposium Steering Committee, I look forward to meeting you in Las Vegas during Microwave Week.

Microwave Week 1987 Schedule

June	Sun 7	Mon 8	Tue 9	Wed 10	Thu 11	Fri 12	Sat 13
International Microwave Symposium							
Complimentary Continental Breakfasts		M	M	M	M	M	
Symposium Technical Sessions			MA	MA	MA		
Panel Discussions			N	N	N		
Chapter Chairman's Dinner			E				
Annual Awards Banquet				E			
Workshops		MA				MA	
Monolithic Circuits Symposium							
Complimentary Reception	E						
Complimentary Continental Breakfasts		M	M				
Symposium Technical Sessions		MA	M				
29th ARFTG Conference							
Complimentary Continental Breakfasts						M	M
Conference Technical Sessions						MA	M
Conference Banquet						E	
Social Activities							
Microwave Journal Reception		E					
Guests' Hospitality Suite		MA	MA	MA	MA	MA	
Guests' Program			MA	MA	MA		
Exhibitor's Cocktail Party				E			

M = MORNING N = NOON A = AFTERNOON E = EVENING

IEEE MICROWAVE THEORY & TECHNIQUES SOCIETY 1988-1989 SCHOLARSHIPS, FELLOWSHIPS AND GRANTS-IN-AID

TWO MERIT SCHOLARSHIPS — for children of MTT-S members at undergraduate level (not limited to engineering), $1,000-$2,500 each, renewable for 4 years, given to meritorious students based on PSAT/SAT test scores, academic record, GPA, class rank, leadership, career goals, significant extracurricular and community activity, etc.

GRADUATE FELLOWSHIPS — several $5,000 fellowship awards each year for graduate research studies in microwave engineering on a full-time basis. Applicants must have attained high academic level in engineering or physics. Faculty Research Supervisor must be MTT-S member.

EDUCATIONAL GRANTS-IN-AID — for individual members of MTT-S and for non-profit institutions, number and amount to be based on proposals submitted, proposed activity and financial justification. Applicant must be MTT-S member of 5 years standing.

For further information on the Merit Scholarships, contact:
Dr. Krishna K. Agarwal
Chairman, MTT-S Education Committee
Sage Labs, Inc.
11 Huron Drive
Natick, MA 01760
(617) 653-0844

For further information on the Fellowships and Grants-in-Aid, contact:
Dr. Jorg E. Raue
Chairman, MTT-S Educational Awards Committee
TRW ESG, 03-2673
One Space Park
Redondo Beach, CA 90278
(213) 535-7409

Requests for information must be made no later than September 11, 1987.

1987 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM SCHEDULE OF EVENTS

MONDAY, JUNE 8, 1987

8:30 am-5:00 pm WORKSHOP M-1: NUMERICAL TECHNIQUES Gable 6	8:30 am-5:00 pm WORKSHOP M-2: AMPLIFICATION IN HIGH POWER SYSTEMS Metro 1, 2, 3	8:30 am-5:00 pm WORKSHOP M-3: NON-INVASIVE MICROWAVE SENSING OF PHYSIOLOGICAL SIGNATURES Palace 3

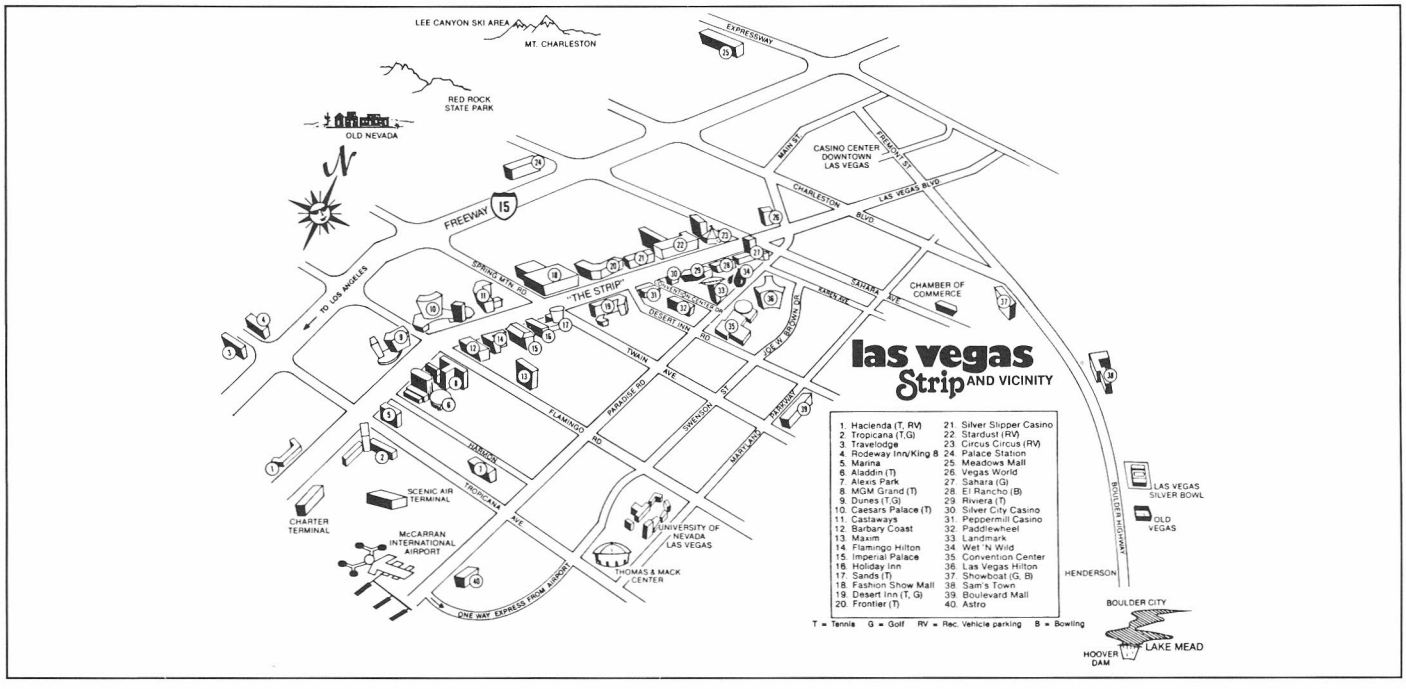
TUESDAY, JUNE 9, 1987

A	8:30 am-10:00 am OPENING CEREMONY Ziegfield Room	
B 10:30 am-12:00 pm JOINT SESSION: NONLINEAR AND POWER CIRCUITS Ziegfield Room	C 10:30 am-12:00 pm COMPUTER-AIDED DESIGN, ANALYSIS AND SYNTHESIS Gable 5, 6, 7	D 10:30 am-12:00 pm MICROWAVE FILTERS AND MULTIPLEXERS Gable 3, 4
	12:00 pm-1:30 pm PANEL: FINANCIAL PLANNING FOR ENGINEERS Gable 5, 6, 7	12:00 pm-1:30 pm PANEL: GaAs MICROWAVE MONOLITHIC INTEGRATED CIRCUITS — MMIC Gable 3, 4
E 1:30 pm-2:50 pm JOINT SESSION: LOW NOISE TECHNIQUES Ziegfield Room	F 1:30 pm-3:00 pm MICROWAVE INTEGRATED CIRCUITS Gable 5, 6, 7	G 1:30 pm-3:00 pm COUPLERS AND POWER DIVIDERS Gable 3, 4
H 3:30 pm-4:50 pm JOINT SESSION: MMIC MANUFACTURABILITY Gable 5, 6, 7	I 3:30 pm-5:30 pm BIOMEDICAL ASPECTS OF MICROWAVES Gable 3, 4	J 3:30 pm-5:30 pm OPEN FORUM I Garland Ballroom

WEDNESDAY, JUNE 10, 1987

K 8:30 am-10:00 am MMW TECHNOLOGY AND APPLICATIONS Ziegfield Room	L 8:30 am-10:00 am MICROWAVE MEASUREMENTS Gable 5, 6, 7	M 8:30 am-10:00 am COMMUNICATIONS SYSTEMS Gable 3, 4
N 10:30 am-11:50 am ADVANCES IN MILLIMETER WAVE SYSTEMS Ziegfield Room	O 10:30 am-12:00 pm NOISE MEASUREMENTS Gable 5, 6, 7	P 10:30 am-11:50 am RADAR SYSTEMS Gable 3, 4
12:00 pm-1:30 pm PANEL: APPLICATIONS OF HEMT DEVICES AND CIRCUITS Gable 5, 6, 7		
Q 1:30 pm-3:30 pm OPEN FORUM II Garland Ballroom	R 1:30 pm-3:10 pm GUIDED WAVES Gable 5, 6, 7	S 1:30 pm-2:50 pm ADVANCES IN MILLIMETER WAVE TECHNOLOGY
T 3:30 pm-5:00 pm EUROPEAN EXCHANGE SESSION Ziegfield Room	U 3:30 pm-5:10 pm WAVEGUIDE DISCONTINUITY STRUCTURES Gable 5, 6, 7	V 3:30 pm-5:00 pm MICROWAVE ACOUSTICS Gable 3, 4
6:00 pm-7:15 pm INDUSTRY-SPONSORED COCKTAIL PARTY Gable Ballroom		
7:30 pm-11:00 pm AWARDS BANQUET Garland Ballroom		

THURSDAY, JUNE 11, 1987		
W 8:30 am-10:00 am OPTICAL TECHNIQUES I Gable 3, 4	X 8:30 am-10:00 am FET AMPLIFIERS Ziegfield Room	Y 8:30 am-10:00 am SOLID STATE DEVICES/CIRCUITS I Gable 5, 6, 7
Z 10:30 am-12:00 pm OPTICAL TECHNIQUES II Gable 3, 4	AA 10:30 am-12:00 pm NON-LINEAR FET APPLICATIONS Ziegfield Room	BB 10:30 am-11:50 am SOLID STATE DEVICES/CIRCUITS II Gable 5, 6, 7
12:00 pm-1:30 pm PANEL: SOLUTIONS TO PROBLEMS EXISTING IN EDUCATING MICROWAVE ENGINEERS Gable 5, 6, 7		
CC 1:30 pm-3:00 pm PHASED AND ACTIVE ARRAY TECHNIQUES Gable 3, 4	DD 1:30 pm-3:00 pm HEMT/MESFET APPLICATIONS Ziegfield Room	EE 1:30 pm-3:00 pm SOLID STATE DEVICES/CIRCUITS III Gable 5, 6, 7
FF 3:30 pm-4:40 pm MICROWAVE FERRITES Gable 3, 4		GG 3:30 pm-5:10 pm HEMT AMPLIFIERS AND DEVICES Gable 5, 6, 7
FRIDAY, JUNE 12, 1987		
8:30 am-5:00 pm WORKSHOP F-4: OPTICAL-MICROWAVE INTERACTIONS Metro 1	8:30 am-5:00 pm WORKSHOP F-5: NONLINEAR CAD AND ASSOCIATED MODELING Metro 2	8:30 am-5:00 pm WORKSHOP F-6: QUASI-PLANAR MM COMPONENTS AND SUBSYSTEMS Palace 3-5
8:30 am-5:00 pm WORKSHOP F-7: DIELECTRIC RESONATORS IN MICROWAVE OSCILLATORS Palace 6, 7	8:30 am-5:00 pm WORKSHOP F-8: PLANNING AND PACKAGING FOR THE NEXT GENERATION OF ICs Metro 3	8:30 am-5:00 pm ARFTG CONFERENCE Gable 3, 4, 5
SATURDAY, JUNE 13, 1987		
		8:30 am-12:00 pm ARFTG CONFERENCE Gable 3, 4, 5



1987 MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM TECHNICAL PROGRAM COMMITTEE REPORT

by Reynold Kagiwada

The 1987 IEEE MTT-S International Microwave Symposium received 416 papers. This exceeds last year's previous record by more than 50 papers. The Technical Program Committee met on January 15, 1987 in Las Vegas, Nevada and worked diligently to formulate the technical program from this large submission of papers. Over 185 papers were submitted from outside the United States, again giving the Symposium a strong international flavor. The 101 members of the Technical Program Committee, broken into 19 subcommittees, had the difficult job of selecting the 222 papers consisting of 93 regular length, 38 short length and 91 open forum papers. These papers give an excellent snapshot of the progress in microwave theory and techniques, covering the frequency spectrum extending from microwave acoustics to optical techniques.

Format

The format of this Symposium is similar to the 1986 Symposium: a Plenary Session will open the Symposium on Tuesday morning. For the first time there will be three sessions held jointly with the Monolithic Symposium starting on Tuesday, June 9. The Microwave Symposium will retain the features adopted earlier such as Focussed Sessions, European Microwave Session, Open Forum, Panel Sessions and Workshops. Regular length papers (20 minutes) and short length papers (10 minutes) make up individual 90 minute technical sessions.

Front left: Alvin Clavin, Kuo-Hsiung Yen, Charles R. Boyd. Back left: John M. Owens, Bruce R. McAvoy, Ted Lukaszek.

This year the Focussed Sessions will cover two topic areas, the frontiers of millimeter waves with emphasis on 60 GHz and above, and for the second year the exciting field of optics/microwaves. The four focussed sessions are:

"Optical Techniques for Microwave Applications I"
"Optical Techniques for Applications II"
"Advances in Millimeter Wave Technologies"
"Advanced Millimeter Wave Systems"

The European Microwave Session will feature three outstanding papers:

"The Detection at Millimeter and Submillimeter Waves," by E. Kollberg
"MMIC Technology and Design in West Germany," by E. Pettenpaul
"Modeling of New Microwave Devices," by G. Salmer

Back left: Peter W. Staecker, Ronald M. Carter, Charles T. Rucker, N. Walter Cox. Front left: Clifford M. Krowne, Michael Dydyk, Robert L. Eisenhart, Joseph F. White.

Special Sessions

This year, four panel sessions offer a broad spectrum from "Financial Planning for Engineers" and "Primary/Continuing Engineering Education" to the highly technical "GaAs Microwave Monolithic Integrated Circuits" and "Applications of HEMT Devices and Circuits." A wide diversity of microwaves are offered in the workshops on Monday, June 8 . Three workshops have been selected. They are "Non-invasive Microwave Sensing of Physiological Signatures," "Amplification of High Power Systems," and "Numerical Techniques for Microwave Field Problems and Their Implementation on Personal Computers." For Friday, June 12, the workshops are "Optical-Microwave Interaction," "Non-linear CAD and Modeling," "Quasi-Planar Millimeter Wave Components and Subsystems" and "Dielectric Resonator Oscillators." These special sessions are covered in detail in an accompanying article by Tatsuo Itoh.

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TPC Report (continued from page 9)

Topics

Once again, GaAs FETs are heavily featured in the Symposium. Including three joint sessions, a total of seven sessions are devoted to this topic. Another three sessions are devoted to solid state devices and their applications. Other areas covered in the Symposium include: field theory, guided waves, biological effects, MIC techniques, filters, passive components, millimeter waves, measurements, microwave systems, microwave acoustics, ferrites and phased arrays.

This outstanding program could only be made possible by contributions of the authors and the dedicated work of the Technical Program Committee. Special thanks are in order for the efforts of the Vice-Chairman Ken Yano; Technical Program Coordinator Cindy Yokono; Special Events Chairman Tatsuo Itoh; Open Forum Chairman Jim Rautio, and Focussed Session Organizers John Horton, Chi Lee and Jim Wiltse.

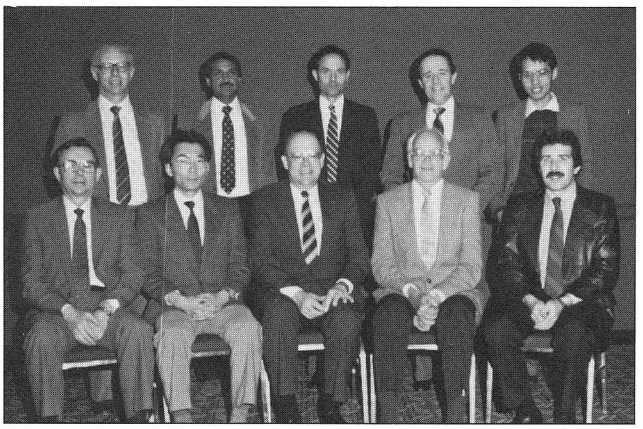
We all look forward to seeing you in Las Vegas in June.

Standing (l-r): Joseph S. Barrera, Edward C. Niehenke, Eugene H. Gregory, Richard A. Sparks. Seated: John R. Lane, Mahesh Kumar, E. James Crescenzi, Mike Malbon, Bernard D. Geller.

Standing (l-r): Bert Berson, Eliot D. Cohen, Lawrence R. Whicker, Barry E. Spielman. Seated: Richard Van Wagoner, Fred J. Rosenbaum, Vladimir G. Gelnovatch, Karl B. Niclas.

Standing (l-r): Harlan Howe, Jr., A. Cardiasmenos, James C. Lin, Arye Rosen. Seated: Roger D. Pollard, Mario A. Maury, Jr., Stephen F. Adam, H. George Oltman, Jr., Glenn F. Engen.

Standing (l-r): George L. Heiter, John B. Horton, David N. McQuiddy, Jr., Kiyo Tomiyasu, Sy Okwit. Seated: Norman R. Dietrich, Chi H. Lee, Ken Yano, Peter G. Petrelis, Krishna K. Agarwal.



Standing (l-r): Ralph Levy, Chandra Kudsia, Albert E. Wiliams, Richard V. Snyder, Long Q. Bui. Seated: James C. Wiltse, Hiroyo Ogawa, Robert Weck, Charles Buntschuh, Nicholas Chrissotimos.

Missing from TPC photos: H.C. Bell, K.J. Button, H. Chilton, J.E. Degenford, D. Dodson, O.P. Ghandi, R. Gilson, J. Goel, R.E. Ham, H. Hieslmair, S. Honickman, R.H. Knerr, D. Maki, G.L. Matthaei, J.E. Raue, H. Sobol, D. Steinbrecher, G.R. Thoren, D. Webb, H.A. Willing

TPC Report (continued from page 10)

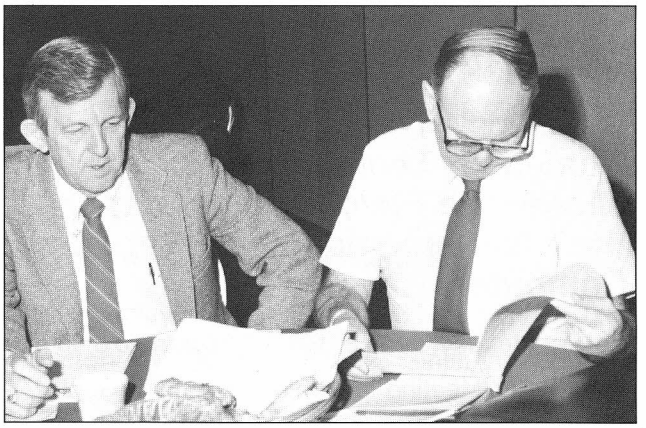
Standing (l-r): Jeffrey B. Knorr, Nicolaos G. Alexopoulos, Tatsuo Itoh, S.T. Peng, Pradeep K. Wahi. Seated: Arvind K. Sharma, Arthur A. Oliner, Ali E. Atia, James W. Mink, Peter LaTourrette.

Albie Williams, Ali Atia, S.T. Peng and Jim Mink deep in contemplation.

Standing (l-r): Paul T. Greiling, J.P. Letellier, Michael E. Kim, Barry S. Perlman, James M. Schellenberg. Seated: Steven J. Temple, Robert A. Pucel, K.C. Gupta, Ulrich L. Rohde.

Bob Pucel and K.C. Gupta determining the suitability of a CAD paper.

Standing (l-r): Steven L. March, William E. Hord, Marvin Cohn, James T. Whelehan, Jr., Jesse J. Taub, Andre VanderVorst. Seated: Ferdo Ivanek, James C. Rautio, Cindy Yokono, Reynold S. Kagiwada.



Bill Hord and Jim Whelehan reviewing a paper.

Special Sessions (continued from page 12)

Abstract:
The workshop will consist of an introductory session of invited presentations, followed by workshop sessions. Contributions in the form of five-minute presentations are being sought in areas such as:

- High power sources including combining techniques
- High efficiency techniques
- Linearization techniques
- High speed pulsed operation (nanosecond)
- Space requirements (weight, volume, vacuum, etc.)
- Thermal effects on design
- Special applications (space, mobile, etc.)

Workshop attendees who wish to present summaries of their work in the above technical areas should send a 200-word abstract to J.B. Horton.

WORKSHOP M-3

Noninvasive Microwave Sensing of Physiological Signatures

Date: Monday, June 8, 1987, 8:30 a.m. to 5:00 p.m.

Location: Meeting in Palace 3; Lunch in Palace 4

Sponsor: MTT-10, Biological Effects and Medical Applications

Organizer: James C. Lin
Dept. of Bioengineering
University of Illinois
Chicago, IL 60680-4348
(312) 996-2331

Speakers:
J.C. Lin, University of Illinois at Chicago
F. Sterzer, RCA, David Sarnoff Research Center
M. Siegel, Michigan State University
K. -M. Chen, Michigan State University
J. Toler, Georgia Tech. Res. Institute
K. Carr, M/A-COM
S. Mizushina, Shizuoka University
F. Bardati, University of Rome

Abstract:
The ability to measure noninvasively the movement of organ systems and to sense time-dependent permittivity change from outside the body opens many fruitful areas of potential biomedical applications. These include noninvasive examination and early detection of cardiovascular, respiratory and pathological abnormalities. A microwave technique to remotely monitor the respiratory movement of humans and animals also has been developed. The technique is capable of registering instantaneous changes in respiration in fully clothed individuals and behind structural walls, including artificially induced apnea and hyperventilation. Microwave radiometric detection of subcutaneous temperature variations may not only provide early detection of peripheral vascular diseases and cancerous growth, but also permit the monitoring of subcutaneous hyperthermic temperature profiles during therapy. This workshop brings together leading experts in the field to review current status and to strategize for the future.

WORKSHOP F-4

Optical-Microwave Interactions

Date: Friday, June 12, 1987, 8:30 a.m. to 5:00 p.m.

Location: Meeting in Metro 1; Lunch in Metro 5

Sponsor: MTT-3, Lightwave Technology

Organizer: Chi H. Lee
Department of Electrical Engineering
University of Maryland
College Park, MD 20742
(301) 454-6852

Speakers (include):
D. Bloom, Stanford University
K. Bhasin, NASA

Abstract:
The workshop is intended as a forum for the exchange of ideas among those who are interested in using optical technology to solve microwave/millimeter-wave problems as well as the microwave aspects of light wave technology. The following areas will be discussed; optical technique for phased arrays, optical generation, control and measurement of microwaves, on-chip optical characterization of MMICs, microwave optical fiber links, chip-to-chip optical interconnects for gigabit circuits, and material and device technology for high speed/high frequency electronics.

The workshop format consists of invited talks which will stress only the concept, current state-of-the-art of the entire field, the problems and bottleneck issues. It is planned to have no more than four invited speakers by presenting their viewpoints following each invited talk. These presentations are limited to five minutes and three transparencies.

There will be a 90 minute time slot allocated for "Optical Interconnection" at the request of the Digital Signal Processing Committee of the MTT-S. This activity will be organized by I. Mack, the Chairman of the Digital Signal Processing Committee.

WORKSHOP F-5

Nonlinear CAD and Modeling

Date: Friday, June 12, 1987, 8:30 a.m. to 5:00 p.m.

Location: Meeting in Metro 2; Lunch in Metro 5

Sponsors: MTT-1, Computer-Aided Design
MTT-6, Microwave & MM-Wave Integrated Circuits
MTT-7, Solid State Microwave and MM-Wave Devices

continued on page 14

Special Sessions (continued from page 13)

Organizers:
B. Perlman
RCA Laboratories
Princeton, NJ 08543
(609) 734-2661

G. Brehm
Texas Instruments
Dallas, TX 75266
(214) 995-5571

Contributors:
P. Blakey, MCC
W. Curtice, RCA Laboratories
M. Golio, Motorola
S. Maas, Aerospace Corp.
A. Pavio, Texas Instruments
R. Pucel, Raytheon
A. Sangiovanni-Vincentelli, University of California
M. Shur, University of Minnesota
M. Steer, North Carolina State
S. Sussman-Fort, State University of New York
Y. Tajima, Raytheon
R. Trew, North Carolina State

Abstract:
The subject of this workshop is nonlinear device modeling and related computer-aided nonlinear circuit design techniques. Analytic and empirical modeling and characterization, equivalent circuit definition and parameter extraction, time and frequency domain analysis techniques and power series approximations will be discussed. Tutorial presentations are planned to familiarize the participants with the subject, formulate and compare device and circuit modeling techniques, algorithms and methodologies. A panel session is planned to stimulate lively discussion with emphasis on applications. This includes computer aided design and modeling for nonlinear applications such as power amplifiers, oscillators, mixers, limiters and switches.

WORKSHOP F-6

Quasi-Planar Millimeter-Wave Components and Subsystems

Date: Friday, June 12, 1987, 8:30 a.m. to 5:00 p.m.

Location: Meeting in Palace 3-5; Lunch in Barrymores

Sponsors: MTT-6, Microwave and MM-Wave Integrated Circuits
MTT-15, Microwave Field Theory

Organizer: Arvind K. Sharma
RCA Laboratories
David Sarnoff Research Center
Princeton, NJ 08543
(609) 734-2387

Speakers:
W.J.R. Hoefer, University of Ottawa, Canada
T. Itoh, University of Texas at Austin
P. Meier, Eaton Corp.
L. Bui, MM-Wave Technology, Inc.
R. Vahldieck, Univ. of British Columbia, Canada
H. Meinel, AEG, W. Germany
A.K. Sharma, RCA Laboratories

Abstract:
Recent progress in quasi-planar millimeter-wave components is attributed to significant advances in integrated fin line technology. In addition, innovative design techniques utilizing other forms of planar transmission lines have led to the development of millimeter-wave subsystems with a high level of integration.

The objective of this workshop is to provide in-depth reviews of the technical advances made so far and focus on the design of various components using this technology. It also will provide a forum for discussions on future directions in the design of components and subsystems.

WORKSHOP F-7

Dielectric Resonators in Microwave Oscillators

Date: Friday, June 12, 1987, 8:30 a.m. to 5:00 p.m.

Location: Meeting in Palace 6 & 7; Lunch in Barrymores

Sponsors: MTT-6, Microwave & Millimeter Wave Integrated Circuits
MTT-8, Microwave Network Theory

Organizer: K. Agarwal
Sage Laboratories, Inc.
11 Huron Drive
East Natick, MA 01760-1314
(617) 653-0844

Speakers:
Dr. Krishna K. Agarwal, Sage Laboratories, Inc.
Mr. S.J. Fiedziuszko, Ford Aerospace, WDL
Dr. A.P.S. Khanna, Avantek
Dr. Darko Kajfez, Prof. Univ. of Mississippi
Dr. Pierre Guillon, Prof. Univ. of Limoges
Dr. Tony Pavio, Texas Instruments

Abstract:
This workshop will highlight the material advances in high stability, low loss, high Q resonators with some underlying theory of fields and coupling structures. Specific applications of the resonators in the design of stable microwave oscillators shall be emphasized. New ideas for designing stable oscillators shall be described with discussions of such topics as phase noise, digital temperature compensation, long term frequency drifts, etc. Each of the panel members will make a presentation on their specific part of the topic. Time allocation for presentation and questions shall be about one-half hour per invited speaker.

continued on page 15

Special Sessions (continued from page 14)

WORKSHOP F-8

Planning the Packaging for the Next Generation of Integrated Circuits

Date: Friday, June 12, 1987, 8:30 a.m. to 5:00 p.m.

Location: Meeting in Metro 3; Lunch in Metro 5

Sponsor: MTT-6, Microwave & Millimeter Wave Integrated Circuits

Organizers:

Bert Berson
Berson & Associates
181 Centre St., Suite 20
Mountain View, CA 94041
(415) 968-2101

Doug Maki
Tachonics
P.O. Box 580
Plainsboro, NJ 08536
(609) 275-2510

Fred Rosenbaum
Washington University
Dept. of Elec. Engineering
St. Louis, MO 63130
(314) 889-6157

Abstract:

The purpose of this workshop is to clarify the challenges that monolithic Silicon and Gallium Arsenide chips present to the package designer and manufacturer.

The next generation of integrated circuits consist of monolithic Silicon and Gallium Arsenide chips operating at microwave frequencies and gigabit rates. This results in new demands on package technology, and with it new opportunities to improve component and system performance.

In this workshop we will discuss the problems involved in packaging the new chip technologies. By reviewing present manufacturing methods used for existing chip technologies and comparing them with the new requirements we will be able to see the directions in which packaging must evolve.

PANEL SESSION

GaAs Microwave Monolithic Integrated Circuits — MMIC

Date: Tuesday, June 9, 1987, Noon to 1:30 p.m.

Location: Meeting in Gable 3 & 4 (For those who purchased lunch, in exchange for your ticket, a box lunch may be picked up in the Gable Foyer).

Sponsor: MTT-6, Microwave & Millimeter Wave Integrated Circuits

Organizer: K. Agarwal
Sage Laboratories, Inc.
11 Huron Drive
East Natick, MA
01760-1314
(617) 653-0844

Panelists:
Dr. Tom Leonard, M/A-COM MAC
Dr. George Kaelin, TRW, Redondo Beach
Dr. D.N. McQuiddy, Jr., Texas Instruments
Dr. Jim Schellenberg, Westinghouse
Dr. Bob Pucel, Raytheon Res. Labs.
Dr. Barry Spielman, NRL

Abstract:

MMIC circuits have been around for a long time. It is fair to say that GaAs MMICs have been long on performance and promise but short on delivery. The performance has been generally achieved in research labs or only in small numbers of custom fabricated parts. Efforts to produce in large quantities have been a challenge to designers and manufacturers. Purity of material and other issues have plagued the MMICs. There has been a push from DARPA, DoD and Tri-Services to firmly establish the MMIC technology in reasonable field quantities. The panel will present their perspective of the technology and the issues involved.

PANEL SESSION

Financial Planning for Engineers, Implications of the New Tax Law on: Financial Planning, Investment Planning, Insurance Planning and Requirements for Keeping Records

Date: Tuesday, June 9, 1987, Noon to 1:30 p.m.

Location: Gable 5, 6 & 7 (For those who purchased lunch, in exchange for your ticket, a box lunch may be picked up in the Gable Foyer).

Sponsor: PACE

Organizer: R.A. Moore
Westinghouse Defense and Electronics Systems Center
P.O. Box 746, MS 70
Baltimore, MD 21203
(301) 765-4027

Speakers From:
Coopers & Lybrand, Auditors for IEEE
Smith Sterno, Insurance Carriers for IEEE

continued on page 16

Special Sessions (continued from page 15)

Abstract:
As we know, the new tax law will challenge all of us in making personal and professional financial decisions. The relationships between pensions, IRAs, 401K accounts, most investments, insurance and many other aspects of our personal and professional financial structures is changing. The speakers will provide an overview of their topics after which the floor will be open for discussion of aspects of topics on personal and professional financial planning of interest to the audience.

PANEL SESSION

Applications of HEMT Devices and Circuits

Date: Wednesday, June 10, 1987, Noon to 1:30 p.m.

Location: Gable 5, 6 & 7 (For those who purchased lunch, in exchange for your ticket, a box lunch may be picked up in the Gable Foyer).

Sponsors: MTT-6, Microwave & Millimeter-Wave Integrated Circuits
MTT-7, Microwave & Millimeter-Wave Solid State Devices

Organizers:

H.J. Kuno
Hughes Aircraft Co.
P.O. Box 2999
Torrance, CA 90509
(213) 517-6378

D.W. Maki
Tachonics Corp.
P.O. Box 580
Plainsboro, NJ 08536
(609) 275-2510

Panelists:
Phil Smith, General Electric (Moderator)
Paul Saunier, Texas Instruments
Sandy Weinreb, Nat. Radio Astronomy Observatory
David Wang, Hughes
Mike Sholley, TRW

Abstract:
Discussions include the application of HEMT devices and circuits for millimeter wave transmitters and receivers, for cooled, low noise microwave receivers and the commercial use of HEMTs.

PANEL SESSION

Solutions to Problems Existing in Educating Microwave Engineers

Date: Thursday, June 11, 1987, Noon to 1:30 p.m.

Location: Gable 5, 6 & 7 (For those who purchased lunch, in exchange for your ticket, a box lunch may be picked up in the Gable Foyer).

Sponsor: Education Committee, MTT-S AdCom

Organizer: Les Besser
Besser Associates, Inc.
3975 East Bayshore Rd.
Palo Alto, CA 94303
(415) 969-3400

Speakers:
Kris Agarwal, Sage Laboratories, Inc.
Stacy Bearse, RF and Microwave Magazine
Clifford Krowne, NRL
Bill Goodin, UCLA Continuing Education
Tim Healy, Santa Clara University
Ed Niehenke, Westinghouse Corp.
Fred Rosenbaum, Washington University

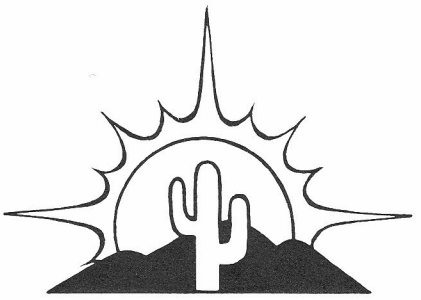
Abstract:
This panel discussion reviews the current educational process available to microwave engineers. Representatives from industry, government, academia and the IEEE discuss fundamental problems facing both undergraduate and practicing engineers, and will seek for a systematic way to improve basic education and to provide meaningful continuing education at various levels. Topics include a review of successful co-op programs, employee and undergraduate student motivations, economic considerations, degree oriented vs. specialized courses and "computer-literacy" of microwave engineers.

EDITOR'S NOTE:

A one day meeting with similar subject matter to that of the Thursday Panel Session was held on April 11, 1987 at Santa Clara University (topic: "Microwave Education in the Bay Area"). Representatives from three groups were invited to attend this meeting:

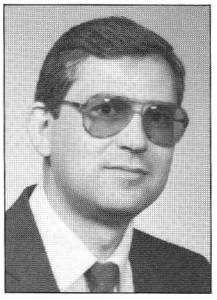
1) Universities near the Bay Area
2) Microwave companies in the Bay Area
3) IEEE MTT Officers (local and national)

If you are interested, information on this meeting can be obtained from George Vendelin, MTT Chapter Chairman, (408) 970-2735, or Professor Tim Healy, Santa Clara University, (408) 554-4482.



1987 MTT-S
Las Vegas, Nevada
June 9-11

1987 MICROWAVE AND MILLIMETER-WAVE MONOLITHIC CIRCUITS SYMPOSIUM



by Yalcin Ayasli

The 1987 IEEE Microwave and Millimeter Wave Monolithic Circuits Symposium will be held at the Bally's Grand Hotel, Las Vegas, Nevada, June 8th and 9th, 1987. This year our Symposium is extended to two full days and an additional parallel session is added on the afternoon of the first day. The two-day Symposium opens on Monday, June 8 and concludes on Tuesday, June 9. The Tuesday sessions are held jointly with the 1987 IEEE MTT-S Symposium following the Plenary Session on Tuesday morning. In addition, on Monday afternoon two parallel sessions are scheduled.

This year, the Technical Program Committee under the Chairmanship of Dr. Derry Hornbuckle, has selected 30 contributed papers and two invited papers for the technical program. The program is divided up into six sessions, covering general areas of Advanced Devices and Millimeter-Wave Techniques, Monolithic Broadband Circuits, Reliability and Control, Millimeter-Wave Receivers and Control Components, Nonlinear and Power Circuits, Low Noise Techniques, and MMIC Manufacturability. The invited paper in the opening joint session on Monday morning, presented by Peter Asbeck of Rockwell, reviews the Heterojunction Bipolar Transistors as they relate to Microwave and Millimeter-Wave Integrated Circuits. On the second day of the Symposium, Don Estreich of Hewlett-Packard presents the second invited paper and gives an overview on Nonlinear Modeling for MMICs.

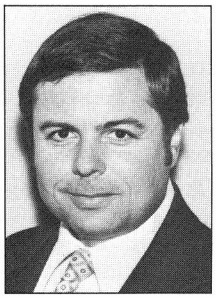
As it is becoming a tradition, a continental breakfast for the Symposium attendees and coffee/tea/soft drink breaks will be available. Symposium attendees and their guest are also invited to a reception on Sunday evening between 6 and 9 p.m. to socialize and meet their colleagues in an informal setting. The reception is to be held in the Caeser's Palace Hotel, which is conveniently located across the street from Bally's Grand.

On behalf of the Steering Committee, I invite you to attend the 1987 Microwave and Millimeter-Wave Monolithic Circuits Symposium in Las Vegas, as I think you will find it an informative and rewarding experience.

1987 IEEE MICROWAVE AND MILLIMETER-WAVE MONOLITHIC CIRCUITS SYMPOSIUM
SCHEDULE OF EVENTS

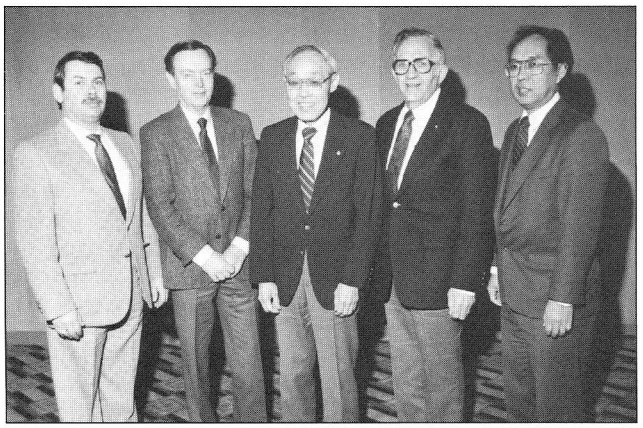
SUNDAY, JUNE 7, 1987		
7:00 pm-10:00 pm MMWMC SYMPOSIUM RECEPTION Nero Room, Caesars Palace		
MONDAY, JUNE 8, 1987		
8:30 am-8:50 am WELCOME BY GENERAL CHAIRMAN AND TECHNICAL CHAIRMAN Ziegfield Room		
I	8:50 am-10:20 am ADVANCED DEVICES AND MILLIMETER WAVE TECHNIQES Ziegfield Room	
II	10:40 am-11:40 pm MONOLITHIC BROADBAND CIRCUITS Ziegfield Room	
III	1:30 pm-3:30 pm RELIABILITY AND CONTROL Ziegfield Room	IV 1:30 pm-3:30 pm MILLIMETER WAVE RECEIVERS AND CONTROL COMPONENTS Gable 1, 2
TUESDAY, JUNE 9, 1987		
V	10:30 am-11:40 am JOINT SESSION — NONLINEAR AND POWER CIRCUITS Ziegfield Room	
VI	1:30 pm-3:00 pm JOINT SESSION — LOW NOISE TECHNIQUES Ziegfield Room	
VII	3:30 pm-4:50 pm JOINT SESSION — MMIC MANUFACTURABILITY	

PRESIDENT'S REPORT



by David N. McQuiddy, Jr.

The first AdCom meeting of 1987 was held in Las Vegas at the Flamingo Hilton on January 15-16. The first meeting is always held in conjunction with the Technical Program Committee meeting to select papers for the Microwave Symposium. The day before, Steering Committees for the International Microwave Symposium (IMS), the Microwave and Millimeter-Wave Monolithic Symposium, and the ARFTG Conference had met to work out the details for our "Microwave Week" in Las Vegas coming up the second week of June.

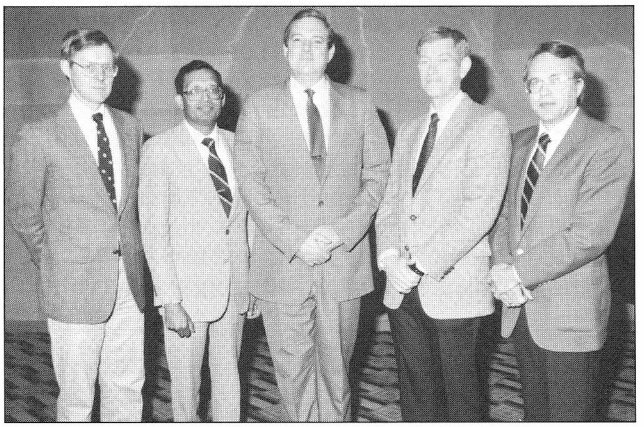


Steven L. March, Ferdo Ivanek, Kiyo Tomiyasu, Theodore S. Saad, Reynold S. Kagiwada.

H. George Oltman, Jr., Harlan Howe, Jr., D. Gary Lerude, David N. McQuiddy, Jr., Steven J. Temple, Mario A. Maury, Jr.

It's always impressive to attend a gathering of our Microwave Society people. There's a common bond of commitment and dedication to professionalism that underlies all these activities and, perhaps, the only way it can truly be appreciated is by being part of it. Joining these activities is easier than you may think. We always seem to find more to do or more we ought to do.

Last year, we experienced an 8.4% growth ending the year with 9,445 members worldwide. In ranking, we were not only the fifth largest but also fifth in the rate of growth of the IEEE Societies. Our increase in membership and symposia activities over the last several years has forced us to continually focus attention on our operations and services. In the Fall 1986 issue of the MTT-S Newsletter (Number 116), I reported on the plans from the Long Range Planning Committee to deal with the challenges we will be facing in the future. AdCom is now beginning to act on these recommendations.



Peter W. Staecker, Krishna K. Agarwal, Edward C. Niehenke, N. Walter Cox, Jorg E. Raue.

Education related programs have been under consideration for the last several years. Kris Agarwal is chairing the Education Committee and presented details of the Undergraduate Scholarship Program to AdCom in January. The Citizens Scholarship Foundation was approved by AdCom to administer our future undergraduate scholarship awards. We expect funding to be approved in June pending some final details yet to be worked out. Jorg Raue has been working on the Fellowship/Grants-in-Aid Program and presented two fellowship candidates who were approved. The Fellowship awards are for $10,000 each. Jorg also had two requests for Grant-in-Aid and it was decided to award only one but to increase the award to $10,000. Jorg Raue will also be concentrating on defining the Visiting Fellow program this year.

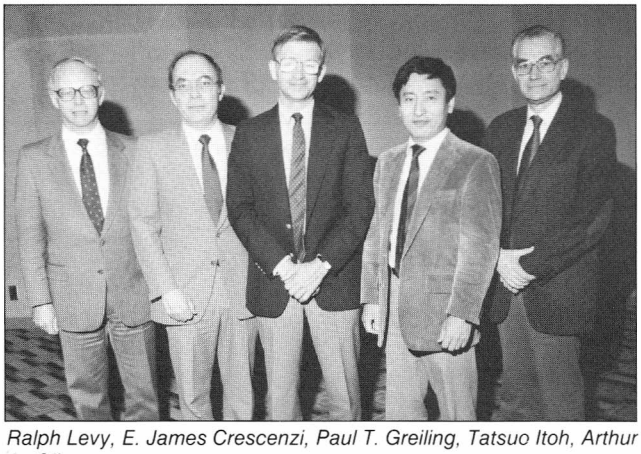
We are still considering an Industry Trade Association. Fred Rosenbaum is working the trade-offs of joining the Electronic Industry Association (EIA) versus a separate Trade Association such as proposed by the Long-Range Planning Committee. These tradeoffs are not clear-cut and it will take time to sort through the

continued on page 19

President's Report (continued from page 18)

implications. It behooves us to consider all factors before committing to a long-term arrangement.

Along with the projects defined in the Long-Range Planning Committee report, we are also planning to implement a refined budgeting process. As we add new areas of activity, fund scholarships and fellowships, and otherwise increase our scope of involvement, the budget issues must be re-addressed. A formal budget is being prepared. Each of the major operating entities of AdCom (Education, Meetings and Symposium, Membership Services, Operations, Publications and Standards, Technical Coordinating, and Long-Range Planning) is providing an income/expenditure forecast that will be used to form our 1988 budget. We have asked IEEE Headquarters to provide additional account numbers so that we can better segregate income and expense actions by operating entity. The plan is to track actual income and expense against the forecast. A more responsible financial control system should evolve from this procedure.

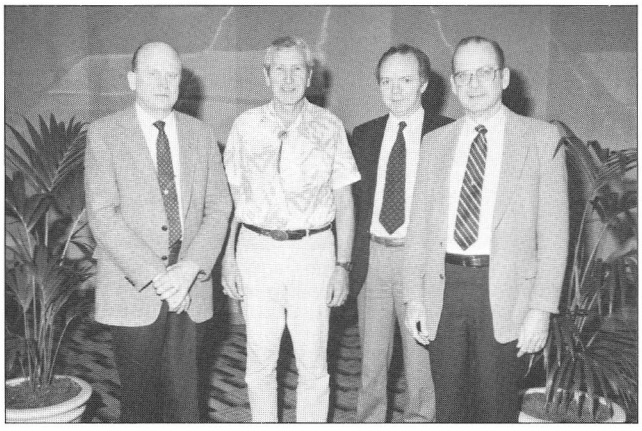


Ralph Levy, E. James Crescenzi, Paul T. Greiling, Tatsuo Itoh, Arthur A. Oliner.

Richard A. Sparks, John W. Wassel, James C. Lin, Robert Moore, Charles Buntschuh.

I chose the items outlined above to emphasize the concern that AdCom has for our future as a society. Barry Spielman, our new Vice President, is now attempting to rank the long-range projects so we will have an order of priority to work to.

"Microwave Week" in Las Vegas is our big event of the year. We hope to have a record turnout for the technical sessions, workshops, panel sessions and the Microwave Exhibition. Mark your calendars and plan to attend. See you there.



Norman R. Dietrich, Alvin Clavin, Andre Vander Vorst, Charles T. Rucker.

Missing from AdCom photos: Vladimir G. Gelnovatch, Martin V. Schneider, Barry E. Spielman, Reinhard H. Knerr.

Peter Staecker, Ed Niehenke and Steve Temple hard at work.

MTT-S President David McQuiddy and MTT-S Secretary Gary LaRude listening attentively.

continued on page 20

President's Report (continued from page 19)

Ted Saad, Reynold Kagiwada, Ferdo Ivanek and Kiyo Tomiyasu paying careful attention while a point is being made.

Charlie Rucker, Ralph Levy listen while Tatsuo Itoh (standing) poses a question.

REPORT OF THE MTT-S TRANSACTIONS EDITOR

by Ralph Levy

The Transactions continues to be in a healthy and vigorous state with no diminution in the rate of papers submitted. I am favorably impressed by the generally high standard of most papers which are well-written and prepared in a commendably professional style.

The inside covers of the Transactions have been updated for 1987, including a new list of reviewers. I decided that it was simpler to do this than to prepare a list of active reviewers for the previous year, since the computer is not programmed suitably. Do let me know if I have missed someone, or if you feel that you would like to review papers.

Paper Statistics

At the end of 1986, I carried out a survey of all papers which I had processed in my term as editor. As of December 31, 1986 I had made 185 final dispositions, of which 10 were to transfer to another jounal **prior** to review. This leaves 175 reviewed papers, of which 114 were accepted, 53 rejected and 8 recommended for transfer to another journal **after** review. The rejection ratio (rejected + transfer) is thus 35%. The figures are given in Table 1, which also indicates other statistics. Actually there were 11 more papers in the revise and resubmit category inherited from the previous editor. Many of these seem to end up as virtually rejected since the authors are "defeated" by the comments of the reviewers and the paper is never resubmitted. On the other hand, resubmitted papers usually are vastly improved, and both authors and reviewers are frequently most appreciative of the favorable effects of this feedback process. The reader will appreciate that many papers which are listed as accepted or rejected went through an intermediate state of revision.

Table 1.
Dispositions of Papers
by the Present Editor in 1986

Published or accepted	114
Rejected	53
Transfer after review	8
Transfer without review	10
Revise and resubmit	31
Under review	49
Dispositions pending	8
TOTAL	273

In financial terms this table is the editorial equivalent of a cash flow report, since it indicates the flow of papers through the system. The "balance sheet" is a snapshot of the financial condition, or in our case the status of the manuscripts in process, and is indicated in Table 2 on the next page.

Note to Authors and Reviewers

I would like to remind authors and reviewers that Short Papers are now restricted to three pages of the Transactions. A simple way to estimate this is simply to divide the total pages of the doubly-spaced typed manuscript (including pages of figures) by four. I am being rather strict on this, since in the past there was a tendency to regard lengthy "short" papers as substandard full papers, rather than as brief contributions describing original work. I hope that reviewers will tailor comments accordingly and appropriately and that

continued on page 21

MTT-S Transactions Editor (continued from page 20)

authors will shorten their contributions if so recommended.

Table 2.
Status of Manuscripts as of 12/31/86

Papers requiring editorial action	
Original submitted manuscripts under review	49
New papers received to be processed	11
Revised manuscripts under review	15
Decisions pending	8
Total manuscripts under review	83
Papers requiring author action	
Awaiting a revised version from author	27
*Papers accepted but awaiting a final version from the author	23
Total manuscripts requiring author action	50
TOTAL MANUSCRIPTS IN PROCESS	133

*These papers constitute the pool from which papers for May 1987 and future issues will be drawn. Seven (7) papers had been received in final version.

Special Issues

Finally, I would like to mention two Special Issues which are currently being planned. The first is scheduled for February 1988 in the field of "Computer-Aided Design," and is edited by K.C. Gupta and Tatsuo Itoh, with a deadline of April 15, 1987. The announcement is in the January issue of the Transactions and the Winter Newsletter. The second on "Quasi-Planar Millimeter-Wave Components and Systems" has more time still available for prospective authors since it is planned for October 1988 and the deadline is January 15, 1988. The Special editor is Arvind K. Sharma and the announcement is included in this issue.

FASCINATING FACTS

- *Most extra-strength pain relievers are just larger doses of the regular-strength drugs. For instance, two extra-strength Tylenol tablets equal three regular-strength tablets. And they offer little, if any, additional pain relief compared to the regular dose.*
- *Ever wonder how much fat is in your favorite cracker? If yours is one of the many brands that bear no nutritional labeling, try rubbing the cracker with a paper napkin. If it leaves a grease stain, there's lots of fat in it.*

University of California, Berkeley Wellness Letter, Des Moines, Iowa Monthly, $12/year

IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

SPECIAL ISSUE ON QUASI-PLANAR MILLIMETER-WAVE COMPONENTS AND SUBSYSTEMS

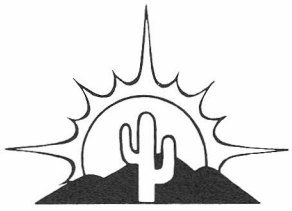
Recent progress in quasi-planar millimeter-wave components is attributed to significant advances in integrated fin-line technology. In addition, innovative design techniques utilizing other forms of planar transmission lines have led to millimeter-wave subsystems with a high level of integration.

MTT-S Technical Committees MTT-6 on Microwave and Millimeter-Wave Integrated Circuits and MTT-15 on Microwave Field Theory are jointly sponsoring a Special Issue on "Quasi-Planar Millimeter-Wave Components and Subsystems" to be published in October 1988. The objective is to present the current state of the art and future trends in the field. Topics of particular interest include but are not limited to the following areas:

- Propagation characteristics of quasi-planar transmission lines, including fin-lines and other planar lines.
- Theoretical and experimental characterization/modeling of uniform, tapered and discontinuity structures.
- New concepts in the design of active and passive components.
- Other related topics in integrated fin-line technology.

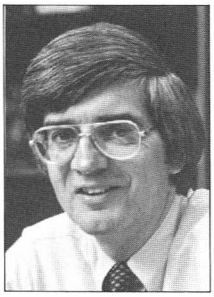
Dr. Arvind K. Sharma of RCA Laboratories and Dr. James C. Wiltse of Georgia Institute of Technology will be guest editors of this special issue. Prospective authors are requested to submit five copies of the manuscript describing original work in the above areas by January 15, 1988 to:

Dr. Arvind K. Sharma, Guest Editor
MTT Special Issue
RCA Laboratories
David Sarnoff Research Center
Princeton, NJ 08540, USA
(609) 734-2387



1987 MTT-S
Las Vegas, Nevada
June 9-11

THE PAPERMILL



by Robert W. Lucky

(Reprinted with permission, from IEEE Spectrum, September 1983, pg. 17)

A long time ago I wrote my first technical paper. I was really proud to see my name on the index of an *IEEE Transactions* issue. I was an author! Many people were impressed — me, my mother, and possibly a few friends and neighbors who happened to glimpse the issue as it lay casually placed on top of the living room coffee table. For years to come, I would be able to drop into technical libraries and find myself incarcerated, as it were, in the dusty stacks. What a marvelous system for publication we engineers had!

In the decades since, I have had occasional glimpses of the Truth. I had one vision of it in the religious quiet of the libraries of the British Museum and of Cambridge University in England, where the actual notebooks of such immortals as Isaac Newton made me shiver with the shared pride of a great scientific heritage. I've marveled at the lasting and renascent wisdom that can still be mined from our great papers — Nyquist in 1928, Rice in 1948, Shannon in 1949 — to name a few in the communications field. Indeed, we engineers have much to be proud of in the record we have left behind.

However, there is another vision of our publications system. It is the myopic, day-to-day vision seen from the participants' perspective — reader, author, reviewer and editor. From their viewpoints it is indeed a miracle that there is any trace of a legacy to pass on to the next month's engineers.

Let's begin by dispensing with the myth that the publications are for the readers (*Spectrum*, of course, is an exception). Naturally, readers are a necessity, but we must be careful not to overestimate their value. For one thing, readers are a nuisance. They continually complain about the worthlessness of the material. They want more practical papers, they say — not these incomprehensible theoretical exercises. Should the journal be so fortunate as to publish one of the practical papers it so rarely receives, the readers complain about the noticeable drop in quality.

Worst of all, the readers make the outrageous claim that they are, in fact, readers. They line the shelves of their offices with reams of pretentious journals, proclaiming to the world their erudition. But I've heard the estimate that the average technical paper has approximately three readers.

It's hard to evaluate this estimate, because there's some kind of uncertainty principle involved in studying readership. The process of measurement affects the system. People will fill out polls saying that they read *n* papers in an average issue: *n* is never equal to zero. No one would admit to not reading a journal that is received. Thus, there is some kind of unspoken agreement that among us engineers *n* equals, say, three. This means that, for example, in the *IEEE Communications Transactions*, with about 15,000 subscribers and 15 papers, the average paper would be read by 3,000 people. If you believe that, you probably also believe that giant vacuum tubes once walked the earth. On reflection, however, any author should be quite pleased to have two or three good readers who would study the paper and pass on its essence to their associates, for this is the way our system truly works.

The author, on the other hand, feels that his or her paper is a great masterpiece written in deathless prose for consumption by the masses. His or her ego is on the line when the precious opus is dropped into the mail for the cruel scrutiny of the review system. The typical author hopes for a telegram from the editor the next day, telling him his paper is so important that it will be published immediately, without review, in a speical issue of the journal with his picture on the cover. As the days tick by without reply, the author's apprehension grows. Has the paper been sent to his arch rival for review? Will its simplicity be apparent, or has it been well concealed by the usual practice of beginning with the general case, and only explaining special examples (where the paper should actually have started) as afterthoughts treated as if they were of no importance to the potential reader? The euphoria attached to the initial generation of the paper dims, to be replaced with a latent anger ready to be fired at hostile reviewers. Meanwhile, the author's energies are consumed in preparing the next paper, entitled "...Part *n*," "Return of ...," or "Further Implications of..."

While this is going on, the reviewer has received the paper, with a request from the editor for an opinion. As befits the dignity attached to rendering such a judgement, the reviewer first hurriedly turns to the back of the paper to see if he himself has been referenced. Probably he has been, since this is how the editor generally selects reviewers, but heaven help the author if he has neglected to refer to an important work published by the reviewer.

I remember being attacked during a patent trial on the basis of a paper I mentioned in a textbook I coauthored. Why, the barrister asked, did I refer to that paper if it in fact had no bearing on my invention? I tried to explain, "When one writes a book like this, one tries not to make any more enemies than one can. General procedure is to refer to everybody in sight. It helps sell books." There were no more questions along this line.

Next the reviewer turns to the front to see who the author is. There are three possibilities. First, it can be a good-friend Allen, who is known never to produce a bad paper, by definition, since it would be professional death to pronounce one of his papers bad. Second, it

continued on page 23

The Papermill (continued from page 22)

could be well-known-faker George, who is trying to slip one through the review process again, hoping to get a less astute reviewer than yours truly. And third, it could be that rarity — the unknown author. (Incidentally, there is always an outcry about removing the author's name from the manuscript; this procedure only delays by milliseconds the recognition of the above categories.) In the case of the new, unknown author, it will be necessary for the reviewer to put in a certain amount of work in order to establish his or her own preeminence in the field. After all, this author should realize just who it is he or she is dealing with.

Finally, in the middle of all this, is the editor. The main skill necesary here is that of translation. The letters from the reviewers and authors must be translated before transmission. "This is the worst paper I have ever reviewed..." becomes "Reviewer A has found a certain deficiency in your paper..." In trying to placate these warring factions, the editor makes few friends. Most of his letters are apologetic. "I realize that the two years that have elapsed in the review of your fine paper may seem exorbitant to you...," he begins. Untouched on his desk is the yearly paper proving Einstein's theory of relativity wrong, and the slew of letters from would-be authors protesting that, being outside the "system," their revolutionary papers will not be accepted by the traditional reviewers. In the back of the editor's mind is the nagging doubt that maybe they're right. The trouble is — it just isn't likely.

Indeed, it's a merry-go-round, and few of the papers published this year will be mentioned in the year 2000. We could debate the relative worthlessness of individual papers. Certainly there are layers and layers of worthlessness, but it's hard to say from moment to moment which papers will in the years to come merit special reconsideration. The system may not be as fair as it should be and everyone concerned will from time to time have legitimate complaints, but I for one think that time has proven its value to all of us. On the whole, it works.

BUSINESS TRAVEL

- ***Catch errors*** *in your hotel bill. Pick a number, from one to nine, when you check in. On all hotel charges, add a tip so that the total comes up with that digit at the end.* Example: *Using the number 3 as your "control" digit, add a tip of $1.24 to a $7.59 room-service bill. When checking out, anything on your bill not ending with a 3 is an error. If the cashier can't produce a signed charge slip, you don't have to pay.*

California Business Traveler's Bulletin, 1 Colby Court, Sacramento 95825, 6 issues, $35/yr.

- ***Top hotel chains*** *(in descending order): Hyatt, Marriott, Sheraton, Hilton, Westin, Holiday Inn, Four Seasons, Inter-Continental, Fairmont and Stouffer.*

Survey of 600 top travel agents and corporate travel managers, reported in Journal of Commerce, 110 Wall St., New York 10005, daily, $160/yr.

DIVISION IV DIRECTOR'S REPORT

by G.A. Thiele

This is my first newsletter column as Director of Division IV. So, I thought I'd write about some of the initial activities of my term in office. Certainly some of the first things that were necessary included simply getting familiar with people and issues. The first was necessary because there were about ten appointments to various IEEE boards and committees that had to be made early on. The five Society Presidents in Division IV, including your MTT President Dave McQuiddy, have been helpful in this regard.

Getting familiar with people also includes the IEEE Headquarters Staff. On January 15 and 16 there was an orientation meeting in New York City for the newly elected members of the Board of Directors. I had the opportunity to meet many people at our headquarters, some of whom had previously only been names in a directory or voices on the phone. The orientation also provided the opportunity to familiarize myself with the functioning of the offices in New York City as well as the Piscataway Services Center. My general impression is clearly that both are very efficiently operated and morale is high. I am aware that there is currently a serious problem with reprints and page charges, but this seems to be the only major exception to my preceding sentence. Further on the plus side, I could comment that the IEEE Controller earned for our Institute over $850,000 by astutely investing short term operating funds during brief periods of non-use. I could also comment about **Spectrum**. I saw numerous awards and letters of praise regarding **Spectrum**. One of these was a letter from Congressman Brown of California praising the **Spectrum** issue last summer on the subject of "verification." Congressman Brown sent copies of **Spectrum's** verification special report to every member of the House of Representatives! (I can remember back when **Spectrum** was started and some members were threatening to drop their membership as a protest against such a magazine. How times have changed!).

March 6-11 I will travel to Brussels to represent the IEEE at an URSI workshop whose purpose is to look inwardly at URSI as well as outwardly at its relationship with other organizations. IEEE representation has been requested by URSI.

In my next newsletter column, I will comment on the URSI meeting as well as how I intend to conduct my responsibilities as Division IV Director. I hope to meet many of you at the various Society symposia.

WRITING AND EDITING — THE TWO HALVES OF LANGUAGE

by Cheryl Reimold
PERC Communications
6A Dickel Road
Scarsdale, NY 10583
(914) 725-1024

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.

PART I. A NEW WAY OF WRITING

East is East and West is West and never the twain shall meet...

As far as the West is from the East...so far should the act of Writing be from the act of Editing. They are distinct, independent activities, performed, it seems, by different halves of the brain. Writing is putting your thought into words. Editing is making the verbal expression palatable and understandable to the people who will read it.

Does this separation of tasks appear obvious? Perhaps — until we look at our own work. Pull out a first draft of something you wrote, a draft for a letter, a memo, a part of a technical report, anything at all. Do you see sentences begun, then crossed out and abandoned? Are there words written all over again? If so, you have *not* separated the writing and editing functions. You have, like almost everyone who picks up a pen or a pencil, begun to write and edit all at once.

Why Change?

Now, what is wrong with this? Why do I suggest writing with *no* changes allowed and *then* editing? Two reasons.

First, you cannot *express your thoughts* clearly in writing if you're occupied in *correcting your writing* at the same time. In an excellent book on the subject, *Writing with Power*, Peter Elbow says that the writer should write his first draft for at least ten minutes without stopping — just to separate the producing from the revising process. At this stage, we should not be thinking about "how to write." Rather, we should be focusing on the subject of our discourse and allowing our creative energy to express our thoughts freely. You can see why. If you're half-focused on describing your latest experiments with freeze drying and half-focused on the words you're using to describe them — you will do each job half-well, at best.

The second reason for writing first, without editing, concerns the content of your work. If you write down all you know about the subject with no corrections or constraints, you will find you know and can express a lot more than you thought. It's like sending a plumb line down to the depths of your knowledge and experience and pulling back all that's there, with no interfacing signals to knock you off course.

So, when you sit down to write, just write. Do not allow yourself to cross out or change a single word. No stopping sentences midway, either. Let your thoughts on the subject flow their way. It may sound easy — until you try it. For to write purely like this is to break the habit of a lifetime. We have all been conditioned to write, cross out, and start again, hobbling along painfully to the end of our messy pages. Why? Mainly, I think, we don't want to waste time. We feel that if we can write and correct *all at once*, we'll have the job done in half the time. Deliberately saving the correcting for after the writing tugs at the time-constricted heartstrings of the busy twentieth-century scribbler.

Time's a wastin'

There is only one way to overcome this fear of time-wasting. I tried it, and I have written first and edited second ever since. Time yourself. Make a strict account of every minute spent writing "the old way," from the moment you pull out the sheet and stare angrily at it to the moment you give it up for final typing. Then, try writing a similar project "the new way." Time yourself again. The new way goes like this:

Take out a sheet of paper and write your topic across the top of it. Begin to write about it. Write anything and everything that comes into your head on the subject, in the order it appears to you. *Force* yourself not to alter a single word. (The effort will send you into a spin the first time, but future writing will prove it's worth it. Over the years, you will save hundreds of hours.)

You will notice two things. First, after the first page or so, your speed of writing will pick up noticeably — because you are gradually freeing your creative faculties of critical clamps. Secondly, you'll be touching on aspects of the subject that you hadn't thought of before. Your hand will hardly be able to keep pace with your articulate thoughts. And — you will feel exhilarated, for what you have just done is allow your creative forces full, free rein.

After you have written all you want to write on the subject, stop. Check to see how much time you spent on that phase of your work. Then put the writing aside and do something else. Even if this phase is brief, do take it. Give your critical faculties a chance to approach your writing with a fresh start.

Now look at what you have written as if you were a third person examining it. You will find that you *feel* like a different person from the one who wrote the draft, for you are now approaching it wholly from the critical viewpoint. Before, your angle was wholly expressive. Now you are ready to edit your work.

continued on page 25

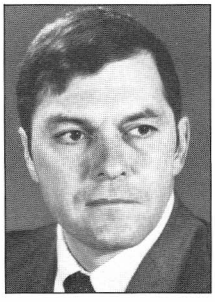
Write and Edit (continued from page 24)

Be Our Own Guinea Pig

Before we come to editing, the second half of the world of writing, I would like you to make an experiment. Set aside ten minutes today. Select a topic that you will have to write about in a memo, a letter, or a report. Take out a pad of paper and write across the top of it. And then, for ten whole minutes, write about that topic without stopping, with *no* corrections, *no* fresh starts. At the end of ten minutes, stop writing. Put your paper away, and try to resist looking at it, preferably until tomorrow! I think you will be surprised at what you see and the way you feel.

Keep the piece of writing until the next column reaches you. Then you'll see how to shape it through careful, systematic editing.

CALL FOR NOMINATIONS



by Vladimir G. Gelnovatch

The MTT-S holds elections annually, usually in the fall, to elect candidates to serve on the AdCom. The nomination slate is provided by the Nominations Subcommittee through a number of algorithms which guarantee best candidates and fair regional and business representation. The ByLaws of the MTT-S state that the Nominations Subcommittee should select a slate of at least two members of the Society for each vacancy which occurs on January 1 of the calendar year following the election. Each nominee is personally contacted to assure his willingness to serve and his ability to attend AdCom meetings. Nominees by the Nominations Subcommittee are selected by the principles of efficiency and geographic and organizational distribution. Elections of the nominees are made by the members of AdCom who are not eligible for re-election at that time.

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

(1) Nomination by the Nominations Subcommittee
(2) Nomination by petition signed by 25 MMT-S members and submitted to the Nominations Chairman prior to September 1, 1987
(3) Informal Chapter suggestions

Note that the route described in item 3 above is strictly informal and does not guarantee nomination. Requests of this type should be pursued between Chapter Chairmen/AdCom liaison member/Nominations Chairman. An additional ByLaw constraint is that AdCom members having served three consecutive terms cannot be nominated by the Nominations Subcommittee for a fourth term.

This year the Nominations Subcommittee consists of eight Society members, half of whom are current AdCom members as specified by the ByLaws. They are:

E.J. Crescenzi, Palo Alto, CA	(415) 493-4141 Ext. 2506
P.W. Staecker, Burlington, MA	(617) 272-3000 Ext. 1602
C.T. Rucker, Atlanta, GA	(404) 894-3420
R. Mattauch, Charlottesville, VA	(804) 924-6086
R. Snyder, Butler, NJ	(201) 492-1207
W. Wissemann, Dallas, TX	(214) 995-2451
J. Whelehan, Long Island, NY	(516) 595-4431
E.C. Niehenke, Baltimore, MD	(301) 765-4573

The wide geographic distribution of the above members should give a reasonably fair representation to all Chapters and members. The geographical and affiliation distribution of the current AdCom membership is given below.

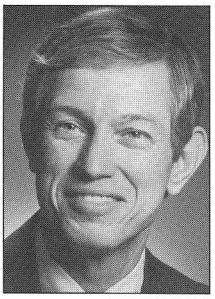
Present AdCom (1987)			Total = 18
East	7	Industry	15
Central	3	Government	2
West	8	Universities	1

Holdover Members (1988) AdCom			Total = 12
East	5	Industry	10
Central	2	Government	2
West	5	Universities	0

Term Ends (1987)			Total = 6
East	2	Industry	5
Central	1	Government	0
West	3	Universities	1

The Nominations Subcommittee needs your help and cooperation. Our slate of candidates will only be as good as the membership provides. The schedule for the Nominations Subcommittee calls for providing a slate of candidates by September 1, 1987. If you have suggestions, please get in touch with the Nominations Subcommittee member nearest you or your Chapter Chairman. Please keep in mind that potential nominees must be able to commit themselves to attend the three AdCom meetings held each year.

MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM SITE SELECTION



by N.W. Cox

The MTT-S Administrative Committee is in the process of selecting sites for the 1993 and 1994 MTT-S International Microwave Symposia.

Chapters interested in hosting the Symposium should contact Walter Cox, Chairman of the Meetings and Symposia Committee at (404) 894-2928. Selection of the 1993 site will made at the June 1987 AdCom meeting, while the 1994 site will be selected at the January 1988 meeting. Proposals have been received from Orlando and Atlanta for the 1993 Symposium; other Chapters wishing to compete for the 1993 Symposium should indicate their interest immediately to allow adequate time for preparation of a letter proposal prior to the June meeting. Letter proposals for the 1994 Symposium are required by early December 1987, but Chapters are urged to make their interest known earlier to obtain guidance regarding preparation of their proposal.

Selection of the 1992 site took place at the Fall 1987 AdCom meeting in Dallas, where Albuquerque was ranked first and Phoenix second. Negotiations are currently in progress with Albuquerque under the direction of George Oltman, Chairman of the Negotiations Subcommittee.

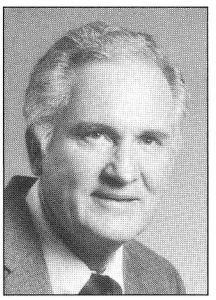
Sites selected for future International Microwave Symposia are listed below along with the Symposia chairmen.

1987	Las Vegas	S.L. March
1988	New York City	C. Buntschuh
1989	Long Beach	C.W. Swift
1990	Dallas	J.D. Wassel
1991	Boston	P.W. Staecker
1992	Albuquerque	J. Hausner

"Nothing in the world can take the place of persistence. Talent will not; nothing is more common than unsuccessful men of talent. Genius will not...the world is full of educated derelicts. Persistence and determination alone are omnipotent. The slogan "press on" has solved and always will solve the problems of the human race."

Calvin Coolidge

SPECIAL ARTICLES FOR THE MTT NEWSLETTER



by J.B. Horton

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:

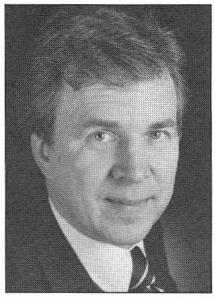
John Horton
TRW
One Space Park
Redondo Beach, CA 90278
(213) 536-3190

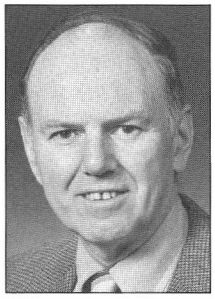
OR

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

This issue's feature article is the first of a two-part article on noise in microwave and optical systems. Thermal, phase and digital noise will be covered with examples of applications of low noise devices to communications, radar and radiometric systems. In Part I, our feature authors, Henry Paczkowski and Jim Whelehan, provide a basic introduction to noise and the theory needed to understand thermal noise in microwave and optical systems. Part II will cover phase and digital noise and will contain a summary of low noise devices currently available for system design. The authors provide a review of the fundamentals of noise, but also point out some interesting pitfalls in the overall system design using extremely low noise front ends.

UNDERSTANDING NOISE: PART I





by Henry C. Paczkowski and James Whelehan

Introduction

Noise establishes a fundamental limitation on the performance of all systems. For the purposes of this article, noise will be defined in a broad sense to be any mechanism that either distorts or degrades the information being received. Noise is generated within a system, but all of the external interfering signals, e.g., lightning, static, ignition noise, are noise sources also and these signals degrade the signal-to-noise ratio (SNR), and therefore degrade system performance. External noise sources are seen by the antenna and are principal main contributors in establishing the sensitivity limits of a receiver. Average noise power, measured using an omnidirectional antenna for several types of external noise as a function of frequency [1], is shown in Figure 1. As will be shown later, these noise components contribute to the equivalent noise temperature of antenna (T_A) and are significant elements in establishing the system sensitivity.

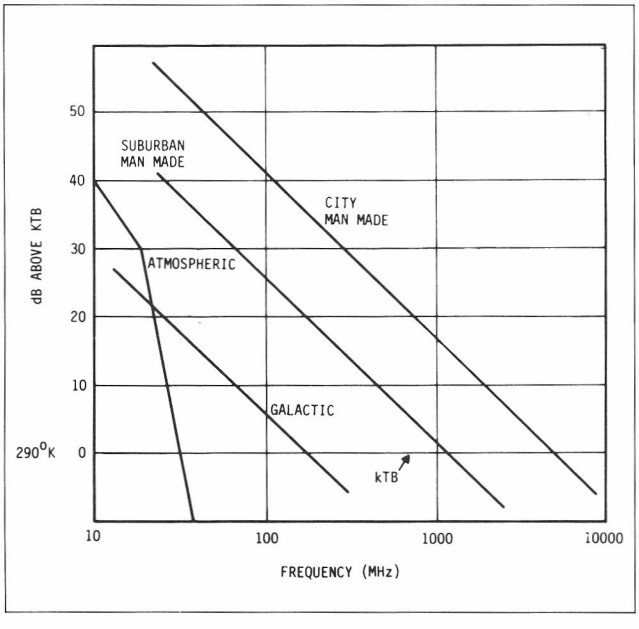


FIGURE 1. Average Noise Power Versus Frequency

Types of Noise

Thermal noise, phase noise and digital noise are the main contributors to degradation of information in today's sophisticated systems. The general discussion of noise, and in particular those factors that must be evaluated in the design of lower noise systems, is a very extensive topic. We will cover only the basics involved, showing the effects of noise on system performance. Thermal noise is the type of noise with which most engineers are familiar and the first part of this two-part article will concentrate on this subject. We will define thermal noise, show what it is, describe what causes it and demonstrate how to calculate its power and its open circuit voltage. We will describe quantum noise, which is an extension of basic thermal noise theory, but whose voltage and power are significant only in systems in the submillimeter and the optical region. Quantum noise must also be considered in the design of cryogenically-cooled systems operating at frequencies above 100 GHz at physical temperatures below 20 K*.

Noise Terminology

Noise figure/noise factor, F (generally expressed in dB) represents the noisiness of a device and will be shown to be directly interchangeable with noise temperature. Sensitivity calculations of receiving systems, as a function of both noise figure (F) and noise bandwidth (B), will be given. The meaning of SNR, the probability of detection (P_D), false alarm rate (P_{FA}) and their relationships will be described.

The many definitions used for system sensitivity, such as Minimum Detectable Signal (MDS), Tangential System Sensitivity (TSS) and their relationship to noise figure/noise temperature will be discussed. The term Noise Equivalent Power (NEP) is used in the optical region and is similar to MDS, except that the noise contributors at optical wavelengths are different from those in the microwave region.

Part I will conclude with discussion of system sensitivity analyses for radar, communications and radiometer systems using gain/noise temperature budgets. The important concepts of system operating noise temperature (T_s) and equivalent antenna noise temperature (T_A) will be presented along with the effects on system sensitivity of some of the system parameters such as interacting VSWRs. Part I ends with a brief discussion of the use of low noise receivers in modern sophisticated systems. Part II will cover phase and digital noise and provide a summary of low noise devices available today.

Thermal Noise — What Is It?

As stated previously, thermal noise limits the ultimate sensitivity that can be achieved in today's high performance systems. It is thermal noise that masks the infinitesimally small signal received on earth from a deep space probe exploring the far reaches of the universe;

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*(where 1 Kelvin (K) = °Centigrade + 273)

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it is thermal noise that prevents an ECM system from detecting a high speed missile that could destroy the platform and its occupants; it is thermal noise that limits the high-speed data rate of a digital communication channel. Thermal noise is the fundamental limiting element of nature that must be considered in the design of any system to ensure that the desired signal, particularly at its lowest power level, is optimally received, amplified, detected and processed with minimum distortion for the intended application. As with all engineering problems, the optimum solution encompasses many design tradeoffs that must be carefully evaluated. These tradeoffs include system performance comparisons as well as cost tradeoffs. The design engineer must fully understand these performance parameters, as well as the measurement techniques to clearly show that the desired performance has been actually received. These quantifiable concepts will be described for some basic systems and how they are used for system noise analysis from the microwave through the optical regions. But first, what is noise, what are its origins and how does it limit system performance?

Physical Mechanisms of Thermal Noise

Electrical current is the flow of electrons. Free electrons in a conductor are always in random motion due to thermal agitation. This random current is generated as a result of the summation of the extremely short current pulses that are caused by the many electrons as they travel between collisions. The amount of motion of the free electrons is directly proportional to the physical temperature of the conductor or device. The higher the temperature, the greater the random motion of the electrons due to thermal agitation. Electrons within a conductor at a physical temperature of absolute zero (0 K) would have absolutely no random motion and, therefore, generate no noise. Free electrons in a conductor at a physical temperature that is greater than 0 K will always have random motion, and as a direct result of thermal agitation, random (i.e., noise) current will always be present.

Signal-to-Noise Ratio (SNR)

If a signal current is also flowing in a conductor, and its magnitude is equal to or less than the noise current generated by the thermal agitation of electrons, the signal would be masked by the noise and it would be extremely difficult to extract the signal from the noise. Therefore, the design of a system requires that the signal power at the detector be greater than the noise power by a predetermined value that allows the desired signal to be processed with a minimal amount of distortion. In general, if we change the design of the system to improve this signal-to-noise ratio (SNR), we have improved the performance of the system.

Johnson Noise

The free electrons which are in random motion in a conductor due to thermal agitation, generate an open

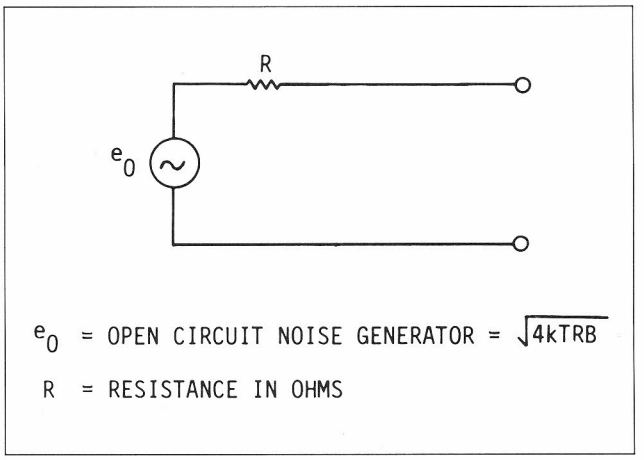

FIGURE 2. Thevenin Equivalent Circuit of Noise Source

circuit voltage at the ends of the conductor. Since a conductor has losses and its resistance is positive, this conductor (or resistor of resistance R) behaves as a noise generator. This noise generator can be represented by a Thevenin equivalent circuit consisting of a noise voltage generator, in series with a resistor whose value represents the resistance of the conductor, as shown in Figure 2. The open-circuit voltage is proportional to the physical temperature of the conductor (in degrees K) and theoretically spans the entire frequency spectrum. The broadband noise spectrum is known as Johnson noise [2], also commonly referred to as white noise. The magnitude of the mean squared thermal noise voltage in a conductor whose resistance is R was shown by H. Nyquist [3] to be:

$$e_0^2 = 4kTR\int_{f_1}^{f_2} p(f)\,df \qquad \textbf{(1)}$$

where

- k = Boltzmann's constant = 1.38×10^{-23} joules/Kelvin
- T = temperature of the resistor in Kelvins
- R = resistance of the resistor in ohms
- p(f) = $hf/kT\ (e^{hf/kT} - 1)^{-1}$
- h = Planck's constant = 6.62×10^{-34} joule-sec
- f = frequency in Hz

Generally, the bandwidth of the device limits the frequency spectrum of the generated noise voltage. For most system applications $hf/kT << 1$, and p(f) is approximately equal to 1. Equation (1) then becomes the well-known thermal noise equation:

$$e_0^2 = 4kTRB \qquad \textbf{(2)}$$

where

- B = bandwidth in Hz

The agreement between the two noise voltage equations is very good for systems that operate at 290 K

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and whose frequency of operation does not exceed 10 GHz. However, if we operate a system at a physical temperature of 4 K, (e.g., a maser) and at a frequency of 20 GHz, the noise power calculated from the standard thermal noise equation (2) is about 13 percent higher than from the Nyquist equation (1). Therefore, the frequency spectrum of thermal noise is not solely white if the ratio of f/T exceeds 10^9 Hz/K. However, for the majority of systems, the approximate thermal noise equation (2) is the one generally used. Using equation (2), a 50 ohm resistor at a physical temperature of 290 K with a noise bandwidth of 1 GHz generates a noise voltage of 28.3 microvolts rms. If the temperature of the resistor is reduced to 20 K, the noise voltage would then be approximately 7 microvolts. The Thevenin equivalent circuit of the 50 ohm resistor at a physical temperature of 290 K is therefore a noise generator, whose open circuit voltage is 28.3 microvolts rms, in series with a noise-free 50 ohm resistor.

Uncorrelated Noise Sources

One unique property of noise is that it is generally uncorrelated, and that independent noise generated voltages have random phases. If two 50 ohm resistors were placed in series, both at a temperature of 290 K as shown in Figure 3, the mean square output voltage is equal to the sum of the mean square voltages generated by the two separate resistors. Each 50 ohm resistor generates an open circuit voltage of 28.3 microvolts rms, so that the equivalent Thevenin voltage for the circuit is 40.0 microvolts ($\sqrt{(28.3)^2 + (28.3)^2}$) and the equivalent Thevenin resistance is 100 ohms.

Available Noise Power, Equivalent Noise Temperature

Available noise power is a very important concept used extensively in solving noise problems and is instrumental in establishing the sensitivity of operating systems. The available noise power (P_{AV}) from a resistor using the Thevenin equivalent circuit is:

$$P_{AV} = \frac{e_o^2}{4R} = \frac{4kTRB}{4R} = kTB \qquad \textbf{(3)}$$

It is obvious from the above that the available noise power from a resistor is completely independent of its resistance value. Using the concept of available power, it is possible to quantify equivalent noise temperature in terms of noise power. For example, the equivalent noise temperature of a resistor is 290 K when it is immersed in a bath temperature of 290 K, and its equivalent noise temperature is 20 K when it is cooled to a physical temperature of 20 K. This concept of using noise temperature for noise power is a very powerful analysis tool and is valid even if the noise power is generated by an object other than a resistance. For example, the sun has an equivalent temperature of about 6,000 K (at 30 GHz), while cosmic background noise has an equivalent temperature of 3.4 K (at 6 GHz). Both measures are frequency-dependent. The equivalent

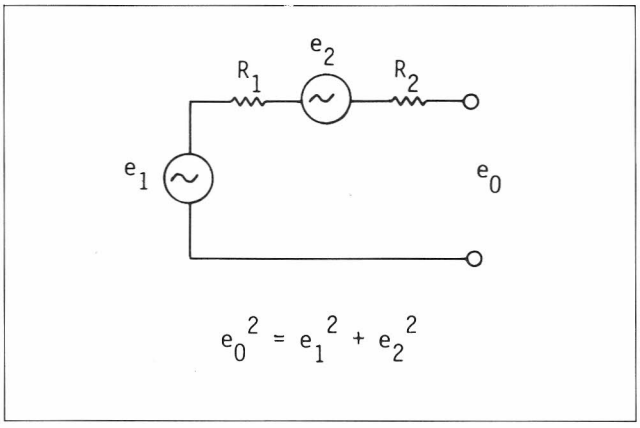

FIGURE 3. Noise Sources in Series

noise temperature of a source is the absolute temperature of a resistor that would produce the same noise output power as the actual source. Thus, it is quite easy to make comparative evaluations of different sources, including receivers and low noise amplifiers, knowing their equivalent noise temperatures. The lower the noise temperature, the better the system, and, generally, the higher the cost. This concept of noise temperature is very fundamental to system noise analysis and will be used extensively throughout this discussion.

Noise Figure

The noisiness of a system, subassembly, etc., is represented by either noise figure or noise temperature and both parameters are used extensively in industry.

The concept of noise figure was initially introduced by H.T. Friis [4]. The noise figure of a network is defined as the ratio of the available signal-to-noise ratio (SNR) at the input of the network (when the temperature of the input termination is at 290 K) to the available signal-to-noise ratio at the output of the network. The single sideband noise figure of a system is then defined by the following:

$$F\ (dB) = 10 \log [(S_i/N_i/S_o/N_o)] \qquad \textbf{(4)}$$

where

$F(dB)$ = noise figure in dB
S_i = input signal power
N_i = input noise power
S_o = output signal power
N_o = output noise power

As is obvious, for a perfect noise-free system, the SNR at the output is equal to the SNR at the input and the noise figure is unity (0 dB). The system does not add additional noise to the input signal. This never occurs in actual practice and some signal-to-noise degradation is always experienced. The SNR at the output is always less than the SNR at the input, and F is always greater than 1.

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Spot Noise

The IEEE has extended the definition of noise figure to include both a spot noise figure and an average noise figure. Spot noise figure is the noise figure of a device at a single frequency. It is very difficult to measure a spot noise figure, since a measuring system with an infinitesimally small bandwidth would be required. For this reason, when noise figure is used, it is generally understood that average noise figure is being used. The relationship between average noise figure (F) and spot noise figure, F(f), is shown by the following:

$$F = \frac{\int F(f)\, G(f)\, df}{\int G(f)\, df} \qquad (5)$$

where

f = input frequency

G(f) = ratio of signal power delivered by the transducer to its output termination to the available signal power from the input termination

SSB vs. DSB Noise Figure

The IEEE definition states "the average noise factor (noise figure) of a 2-port transducer is the ratio of (1) the total noise power delivered by the transducer into its output termination when the noise temperature of its input termination is standard (290 K) at all frequencies, to (2) that portion of (1) engendered by the input termination." This definition only applies to single response receivers and is generally understood to be a single sideband (SSB) noise figure. Some receivers not only respond to the band of frequencies occupied by the signal, but also to other frequency bands. For example, a mixer front end has responses in a band of frequencies equally spaced on both sides of the local oscillator frequency, one of which is the desired signal response while the other response is designated as the image response as shown in Figure 4. Both of these input bands at the RF frequency are converted to the same IF frequency. It is obvious that any additional responses that are converted to the same IF will add additional noise to the system and degrade the output signal-to-noise ratio, thereby effectively increasing the noise figure and degrading the sensitivity of the system.

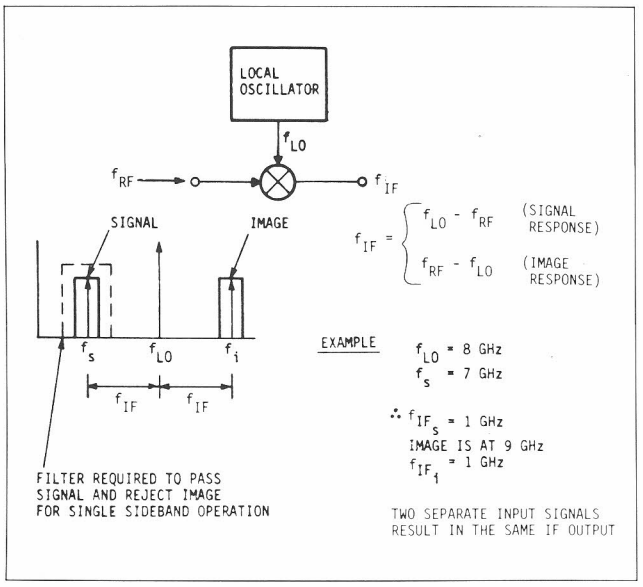

FIGURE 4. Frequency Response of a Mixer Front End

Referring to Figure 4, assume that we have a system with a mixer front end following the antenna. Using this receiver for a radar application, the desired signal, after being downconverted, is present at the IF output as well as the combined noise power from both the signal channel and the image channel. In effect, we have produced one channel of useful signal and two channels of noise at the output of the mixer. Using this same receiver for a radio astronomy application, broadband noise received from the stars is the "signal" of interest, and therefore, the desired signal exists in both the signal and image bands. We now have two useful channels of signals and two channels of noise. This is called a double response receiver and the noise figure for the system is defined to be the double sideband (DSB) noise figure. A broadband noise source is generally used to measure the noise figure of this front end, as this basically emulates a radio astronomy receiver. In a radar application, the noise figure of this receiver would be 3 dB greater than that measured with the broadband noise source. It is very important to know whether single sideband or double sideband noise figure is being quoted by a manufacturer. In most cases, it is assumed to be single sideband, but it is important for the system engineer to fully understand this concept.

Cascaded Noisy Amplifiers

The calculation of the overall noise figure performance of a system is an equally important concept that must be understood by system designers. Let us consider a series of amplifiers in cascade as shown in Figure 5. Considering only the first amplifier which is characterized by its single sideband noise figure (F), gain (G) and noise bandwidth (B), the total noise power and its output (N_{T_0}) is:

$$N_{T_0} = FGk\ 290B = FGkT_0B \qquad (6)$$

where T_0, by definition, is 290 K.

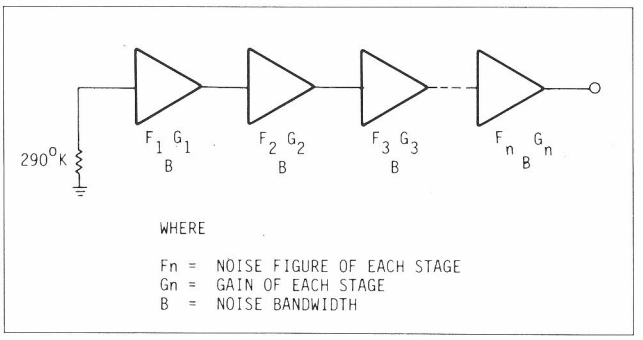

FIGURE 5. Amplifiers in Cascade

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Cascading the second stage to the first stage, the total noise output power of the two cascaded amplifiers is the summation of total noise power due to the first stage plus the noise power added by the second stage. The noise figure for the two stage cascade is then:

$$F_{12} = F_1 + \frac{F_2 - 1}{G_1} \qquad (7)$$

where

F_{12} = noise figure of two-stage cascade
F_1 = noise figure of first stage
F_2 = noise figure of second stage
G_1 = gain of first stage

It should be noted that these calculations are performed using power ratios and the final result is converted to noise figure in dB. As more stages are added, the noise figure for the entire cascade of amplifiers is:

$$F_{1,n} = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \ldots \frac{F_n - 1}{G_1 G_2 \ldots G_{n-1}} \qquad (8)$$

where

$F_{1,n}$ = overall noise figure of cascaded amplifiers (power ratio)
F_i = noise figure of each amplifier (power ratio)
G_i = gain of each amplifier (power ratio)
i = stage designator (1, 2, 3, etc.)
n = last stage in the series

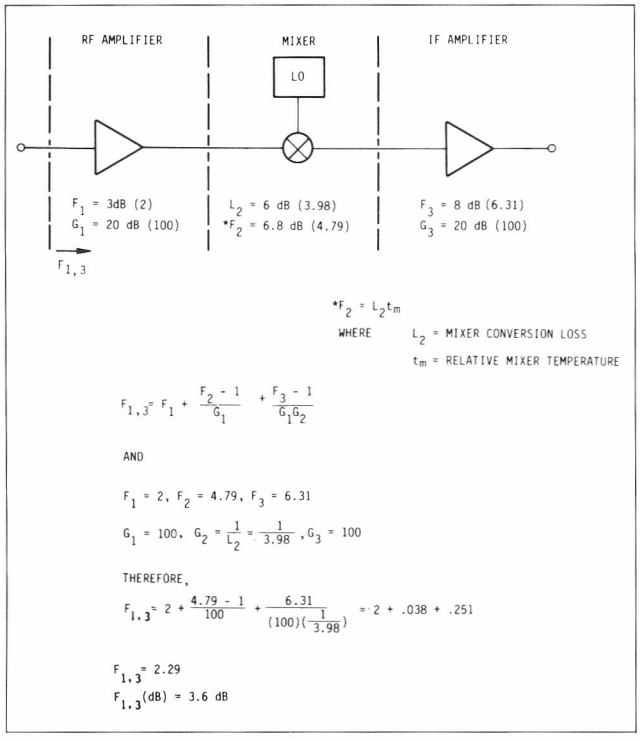

FIGURE 6. System Noise Figure Calculations

All the above calculations assume that the input is terminated in a matched load whose physical temperature is 290 K. An example of a noise figure analysis for a superheterodyne receiver is shown in Figure 6. The mixer conversion loss can be used in equation (8) ($G_2 = 1/L_c$ where L_c is the conversion loss of the mixer). In most system calculations, the equivalent antenna temperature is generally not 290 K, making system operating noise figure calculations cumbersome. As will be shown, this becomes a relatively simple calculation to perform when noise temperature is used instead of noise figure.

Noise Temperature

Noise figure was used for many years until low noise receivers (i.e., masers, paramps, etc.) were introduced to the marketplace. It then became more convenient to use "effective noise temperature." Noise temperature and noise figure are equivalent and can be used interchangeably. This can readily be shown by the following analysis. Referring to Figure 7,

$$S_o = GS_i \qquad N_o = GN_i$$

where

S_i = signal power at the input
S_o = signal power at the output
G = gain of the amplifier
N_i = noise power at the input = kT_0B
N_o = noise power at the output

then

$$(S_i/N_i) = (S_i/kT_0B)$$

and

$$S_o = GS_i$$
$$N_o = GkT_0B + GkT_eB = Gk(T_0 + T_e)B$$

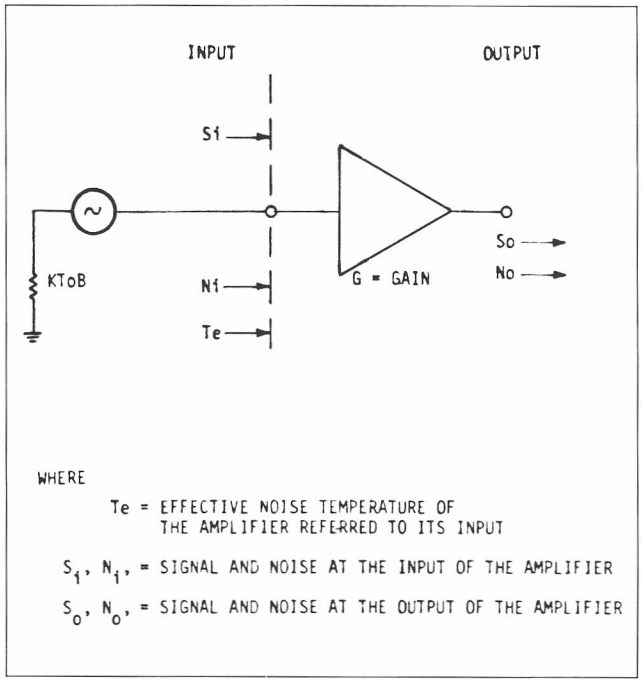

FIGURE 7. Simplified Low Noise Amplifier

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where T_e is the effective input noise temperature of the amplifier expressed in Kelvins and is referred to the input of the amplifier. T_e is determined by the resistive losses and equivalent noise sources embedded in the amplifier. By solving the above equations for noise temperature, and using the definition of noise figure previously given, it can readily be shown that:

$$T_e = (F - 1)\ 290 \qquad \textbf{(9a)}$$

and

$$F = \left(\frac{T_e}{290} + 1\right) \qquad \textbf{(9b)}$$

This shows the direct interchangeability of noise figure and noise temperature. As an example, let us show the relationship of noise temperature and noise figure as applied to a 3 dB attenuator. The noise figure of a 3 dB attenuator is 3 dB and the SNR at the output is one-half the SNR at the input to the attenuator. Using equation (9a) for noise temperature,

$$T_e = (2 - 1)\ 290 = 290$$

Therefore, the noise temperature of a 3 dB pad is 290 K, and the gain is −3 dB for use in system noise temperature calculations.

One of the main reasons for using noise temperature is the widespread use of low noise amplifiers. For example, a typical communication ground terminal which uses a parametric amplifier as an LNA has a noise temperature of 30 K and covers the 3.7 to 4.2 GHz satellite communication downlink. Other LNAs such as masers have noise temperatures that are less than 10 K. If noise figure were used, the 30 K noise temperature converts to a noise figure of 0.43 dB and 10 K converts to 0.147 dB, cumbersome values to manipulate. A photograph of a redundant 3.7 to 4.2 GHz parametric amplifier subsystem is shown in Figure 8.

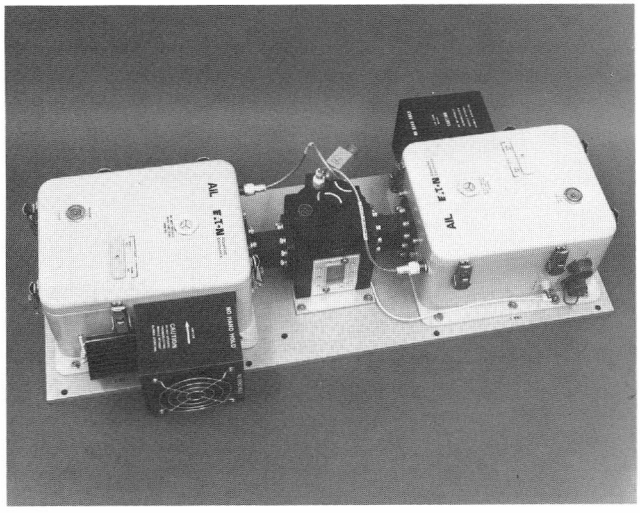

FIGURE 8. Redundant Parametric Amplifier LNA Subsystem

Sensitivity

In typical receiver applications, the signal power must be greater than the available noise power (kT_0B) at the input to the system. If the input signal power is equal to kT_0B, the SNR is just equal to 1. For example, for

$N_i = kT_0B = k290B$
k = Boltzmann's constant = 1.23×10^{-23} joule-sec
B = 1 MHz

the total noise power generated by the 290 K load is 3.57×10^{-12} milliwatts. Expressing this power level in dBm,

$$P\ (\text{dBm}) = 10 \log P\ (\text{milliwatts}) \qquad \textbf{(10)}$$

Thus, the power represented by the 290 K load with a noise bandwidth of 1 MHz is −114 dBm. If this termination is placed at the input of an ideal receiver (F = 0 dB), the sensitivity of the system (defined as that signal power which equal to the noise power) is −114 dBm. This is the fundamental limit of sensitivity of the system and cannot be improved unless the equivalent noise temperature of the input load (which is normally the antenna) is lowered. The sensitivity of the receiver can also be improved by narrowing the bandwidth of the system. For an ideal receiver (F = 0 dB) with an input that is terminated with a 290 K load, a set of sensitivity numbers that are handy for calculation are:

Bandwidth	Sensitivity
1 KHz	−144 dBm
1 MHz	−114 dBm
1 GHz	−84 dBm

Noise Bandwidth

The sensitivity of a non-ideal system (F>0 dB) is degraded from these values due to the higher receiver noise figure. It is important that the correct value of noise bandwidth is used when calculating system sensitivity. Noise bandwidth is not the 3 dB bandwidth normally used in most circuit calculations, but is defined by the following:

$$B = \frac{1}{|H(f_0)|^2} \int_{-\infty}^{\infty} |H(f)|^2\, df \qquad \textbf{(11)}$$

where
$H(f)$ = frequency response of the network
f_0 = frequency of maximum response (generally the midband frequency)

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A simple comparison of noise bandwidth and 3 dB bandwidth is shown in the following table.

Type of Response	# of Stages	Ratio of Noise Bandwidth to 3 dB Bandwidth
Single-Tuned	1	1.57
	2	1.22
	3	1.16
	4	1.14
	5	1.12
Double-Tuned	1	1.11
	2	1.04
Gaussian	1	1.065

Although the error between noise bandwidth and 3 dB bandwidth does not generate a large error in most cases, it should be considered when making very detailed sensitivity calculations.

Example: EW Receiver Sensitivity

With the above information, we can now determine the noise figure requirements for a simple EW receiver. The system is to be designed to have a probability of detection (P_D) of 90% with a false alarm rate (P_{FA}) of 10^{-3} for a single pulse detection. This means that 90% of the signals that cross a preset threshold voltage at the detector are caused by actual targets. The probability of detection depends only on the signal-to-noise (SNR). The probability of false alarm is the probability that the threshold voltage is exceeded when no signal is present and these false signals are triggered by noise spikes which cross the set voltage. Using the curves shown in Figure 9, the minimum SNR required for this condition to be met is approximately 10 dB. The equivalent antenna temperature is assumed to be 290 K and the noise bandwidth of the receiver is 100 MHz to pass the narrowest radar pulse expected. The system is to be designed to have a sensitivity of −80 dBm. We must now determine the required noise figure of the system to meet this requirement. Sensitivity can be calculated from the following:

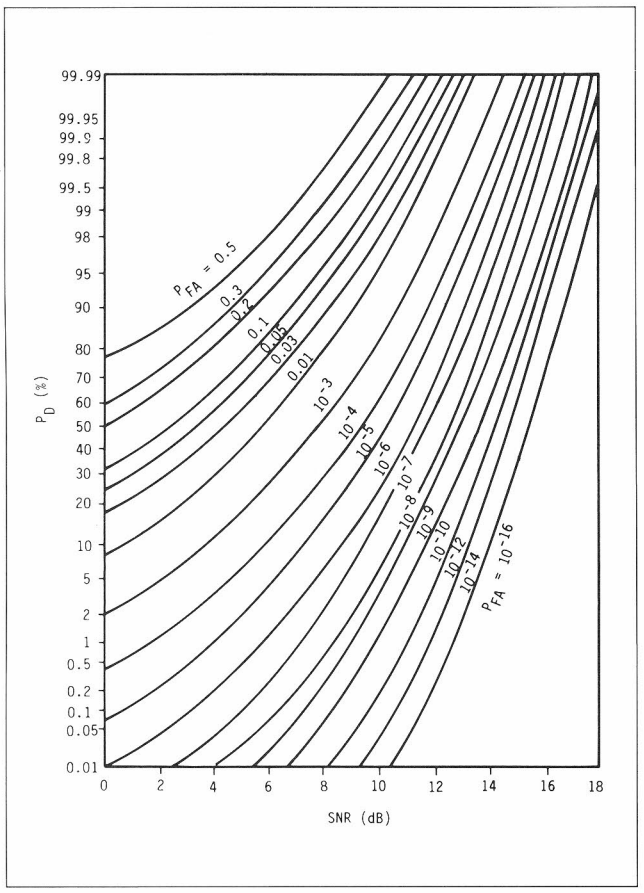

FIGURE 9. Predetection SNR versus P_D for Various Values of P_{FA}

$$S = (k290B)\,(F_R)\,(B_r)\,(S/N) \qquad \textbf{(12)}$$

where

S = sensitivity of the system = −80 dBm

k290B = available noise power of 290 K resistor (−114 dBm for a noise bandwidth of 1 MHz)

F_R = noise figure of the receiver

S/N = SNR = 10 dB [required for $P_D = 0.9$ and $P_{FA} = 10^{-3}$]

B_r = ratio of system bandwidth to 1 MHz (20 dB for this example)

Therefore

$$F_R = \frac{S}{(k290B)\,(B_r)\,(S/N)}\ (\text{Power Ratio}) \qquad \textbf{(13)}$$

or in dB,

$$F_R\,(dB) = S|_{dBm} - (k290B)|_{dBm} - B_r|_{dB} - (S/N)|_{dB}$$

and

$$F_R(dB) = -80 + 114 - 20 - 10 = 4$$

Therefore, a receiver noise figure of 4 dB is required to meet the overall system requirements.

Other system sensitivity definitions commonly used in industry are Minimum Detectable Signal (MSD) and Tangential Sensitivity (TSS). These parameters and the lossless mismatch effect will be discussed before addressing systems performance criteria.

Minimum Detectable Signal (MDS)

MDS is defined to be a signal level that is just equal to the noise level in a system (S/N = 1). The most common method for measuring MDS is to measure the output noise power with no signal applied. The signal level is then increased until the output level increases by 3 dB (signal power then equals noise power). The input

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power level is then the MDS of the system. For the intercept receiver just described, the MDS is calculated using equation (12) with S/N equal to 1 (0 dB):

$$MDS = -114 + 4 + 20 + 0 = -90 \text{ dBm}$$

Tangential System Sensitivity (TSS)

Tangential Sensitivity is a term generally associated with radar receivers that use an oscilloscope to measure the magnitude of the incoming pulse. When observing a radar pulse on an oscilloscope display, the tangential sensitivity is determined when the bottom of the noise pulse just equals the top level of the noise floor without the pulse present. This is shown in Figure 10. As is obvious, the reading is very subjective and depends on the instrument as well as the operator. It has been experimentally determined by Frohmaier [5] that at the TSS, the signal is 8 dB above the noise level. Using the previous intercept receiver example, (S/N) is now 8 dB and the TSS of that system is:

$$TSS = -114 + 4 + 20 + 8 = -82 \text{ dBm}$$

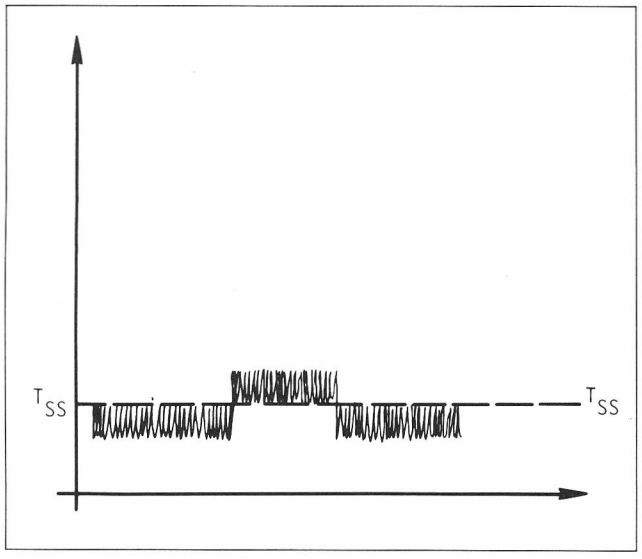

FIGURE 10. Oscilloscope Display to Determine T_{SS}

Lossless Mismatch Effect

One of the least understood effects in analyzing noise problems is the lossless mismatch and its effect on system sensitivity. The calculation of system noise temperature assumes available noise power, and actual mismatches in the system are not generally considered. However, a lossless mismatch does have an effect on system noise performance, but not in the manner that is generally perceived. A component that readily illustrates this effect is a bandpass filter with loss mechanisms due to both reflection and dissipation which can be modeled as shown in Figure 11. Both of these loss contributions are particularly apparent at the band edges where they can be relatively high. Using Figure 11(b) and the following definitions:

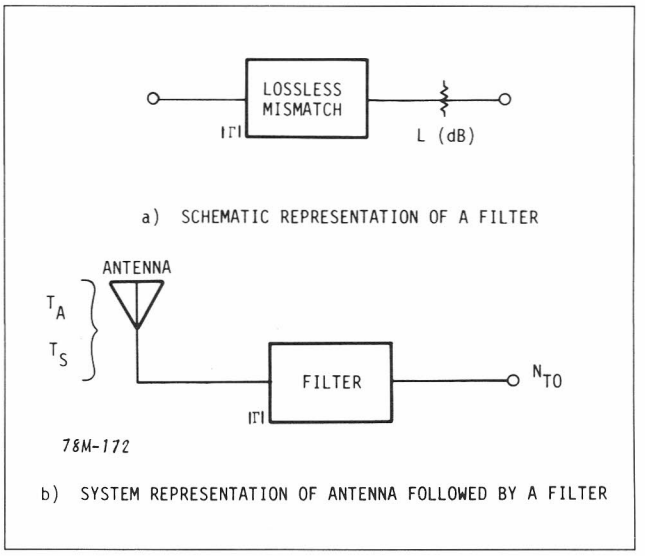

FIGURE 11. Mismatched Input Filter

$|\Gamma|$ = input reflection coefficient
T_A = available noise temperature of the antenna
T_s = equivalent available signal temperature at the antenna port

The total available signal output power at the output of the mismatch is $KT_eB\,(1 - |\Gamma|^2)$, while the available noise output power (N_{T_0}) at the same point is $T_A\,(1 - |\Gamma|^2)$. The signal-to-noise ratio at the input of the system before the mismatch is T_s/T_A, while the SNR after the mismatch is:

$$\frac{S}{N} = \frac{T_s\,(1 - |\Gamma|^2)}{T_A\,(1 - |\Gamma|^2)} = \frac{T_s}{T_A} \qquad (14)$$

showing that the SNR at the output is the same as that at the input. Therefore, applying the definition of noise figure, no noise degradation occurs. A lossless mismatch does not degrade SNR or add additional noise to the system. The dissipative line that represents the filter loss will directly degrade the noise figure of the system and must be included in the system gain/noise temperature budget.

However, the lossless mismatch does have an interactive effect on system noise performance that must be considered. Using the system block diagram shown in Figure 12 which includes an antenna, a lossless mismatch, and an LNA, the SNR for the ideal case (no mismatch) is:

$$\frac{S}{N} = \frac{P_s}{kB\,(T_A + T_e)} \qquad (15)$$

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where

P_s = received signal power
T_A = antenna equivalent noise temperature
T_e = noise temperature of LNA
B = noise bandwidth
k = Boltzmann's constant

If a mismatch occurs between the antenna and the LNA, the SNR is:

$$\frac{S}{N} = \frac{P_s (1 - |\Gamma|^2)}{kB [T_e + T_A (1 - |\Gamma|^2) + T_L |\Gamma|^2]} \quad \textbf{(16)}$$

The SNR of the ideal system is degraded in the following manner:

1) Some of the signal available from the antenna into a matched system is reflected and the delivered power is less than the available power by $(1 - |\Gamma|^2)$.
2) The same effect is also true of the noise power received from the antenna and its magnitude is also reduced by $(1 - |\Gamma|^2)$ and the SNR remains the same as previously shown.
3) An additional term, $T_L|\Gamma|^2$ is added to the denominator which accounts for the noise contribution of the resistive termination in the LNA which acts as a noise generator. This noise propagates towards the antenna where a portion of it is reflected back by the mismatch and is amplified by the amplifier, adding noise to the system (for a perfectly matched input, no SNR degradation occurs).

If we now use the above equation to determine the magnitude of the degradation,

$$\Delta T = \frac{|\Gamma|^2 (T_e + T_L)}{1 - |\Gamma|^2} \quad \textbf{(17)}$$

As an example, let us assume we have a parametric amplifier with a noise temperature (T_e) of 35 K and that the circulator load is at 50°C (323 K). For an antenna mismatch of 2.0:1 ($|\Gamma| = 0.33$), the system noise temperature degradation (ΔT) is 44.8 K. This is greater than the noise temperature of the paramp, which is a severe penalty to pay for a low noise amplifier, particularly considering the price of a 35 K LNA. If the magnitude of the VSWR were reduced to 1.25:1, the ΔT is then 4.5 K. It is quite obvious that system noise temperature degradation changes quite rapidly with a mismatch placed at the wrong location.

System Performance Criteria

It is not possible to discuss all of the various architectures and system configurations in detail here. However, three basic types of receivers do satisfy many applications and form the baseline for a wide host of systems. These classfications are communications, radar and radiometry. The transmitting and signal processing techniques are quite different for each of these

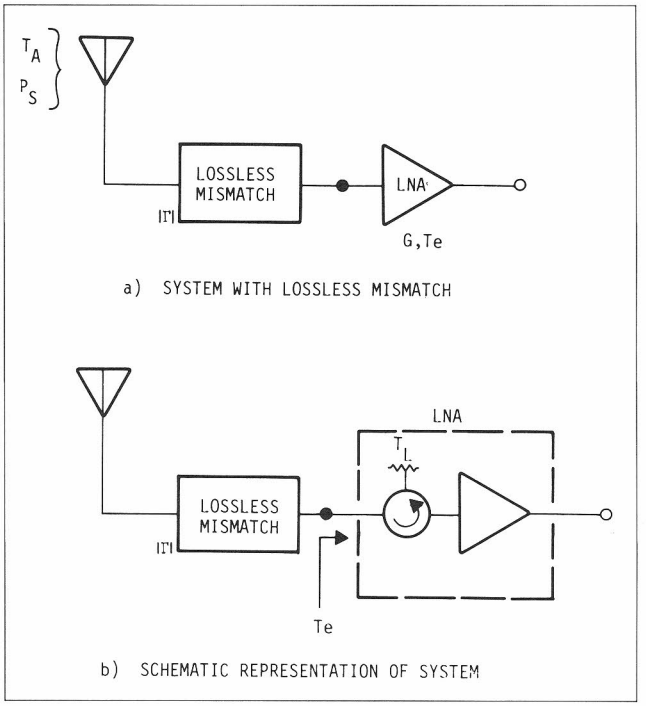

FIGURE 12. System Block Diagram

systems, but the noise analysis is very similar. The quality of each of these receivers can be analyzed by a specific performance criteria that is directly related to its application. Communication receivers used for satellite communications systems can be judged by the ratio of antenna gain to the system operating noise temperature (G/T_s), generally expressed in dB. A radar system can be evaluated by the maximum range at which a defined target can be detected is directly proportional to $(P_T/T_s)^{1/4}$, where P_T is the effective radiated power and T_s is the system operating noise temperature. For a radiometer system, the important criterion is the detectability of very low level noise-like signals. The minimum detectable signal (ΔT) from an extended target is again proportional to T_s. A summary of the system performance criteria for these different generic systems is shown in Figure 13. It is obvious that T_s, which is the sum of the equivalent antenna noise temperature (T_A) and the equivalent receiver noise temperature (T_R), must be minimized in each application to improve system sensitivity.

Example: Communication Receiver

Communication systems can vary from a single channel point-to-point ground communication system to multiple-channel sophisticated ground-based satellite communication receiving equipment with very large antennas and low noise amplifiers. A simplified block diagram of a basic communication receiver is shown in Figure 14. A signal is captured by the antenna, passed through a low-loss transmit reject filter, amplified by a low-noise RF amplifier, and then downconverted to an appropriate intermediate frequency. All of these components have dissipative loss and

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Understanding Noise (continued from page 35)

therefore contribute to a degradation in the received SNR. As shown in the gain/noise temperature budget, the components in front of the RF amplifier add directly to the system noise temperature, while the noise contribution of the second stage, T_{ss}, (due to the components following the amplifier) depends on the amplifier gain. The amount of noise added is also a function of the physical temperature of the components. A component with dissipative loss, such as the filter, adds $(L-1)T_0$ to the noise temperature, where L is the loss of the filter (power ratio) and T_0 is its physical temperature. After being converted to baseband, the incoming signal is processed with the necessary post detection circuitry.

For a satellite communications ground receiving system, the critical downlink performance criteria is (G/T_s). This can be easily seen from the following [6]:

$$\frac{C}{N} = \frac{(EIRP)\,(G/T_s)}{L_1 L_2 k B} \qquad \textbf{(18)}$$

where C/N is the carrier* to noise ratio and is very similar in concept to SNR previously discussed. The higher the ratio of carrier-to-noise, the better the communication system. Defining the elements in the above equation:

EIRP = effective isotropic radiated power from the satellite, which is the product of the transmitter power and the gain of the antenna. The EIRP is fixed by the satellite designer and is a given with which the system engineer must work.

L_1 = propagation and other downlink losses. For a geostationary satellite L_1 is 197 dB at 4 GHz.

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*i.e., the signal power in the communication channel

RECEIVER TYPE	PERFORMANCE CRITERIA
• COMMUNICATION	$\frac{G_{ANT}}{T_S + T_R}$
• RADAR	$\left[\frac{P_T}{T_A+T_R}\right]^{\frac{1}{4}}$
• RADIOMETRIC [8]	$\frac{T_A + T_R}{\sqrt{B_{IF}\tau}}$

$T_S = T_A + T_R$
T_A = EQUIVALENT ANTENNA NOISE TEMPERATURE
T_R = RECEIVER NOISE TEMPERATURE
B_{IF} = IF BANDWIDTH
τ = INTEGRATION TIME CONSTANT

FIGURE 13. Receiver Performance Criteria

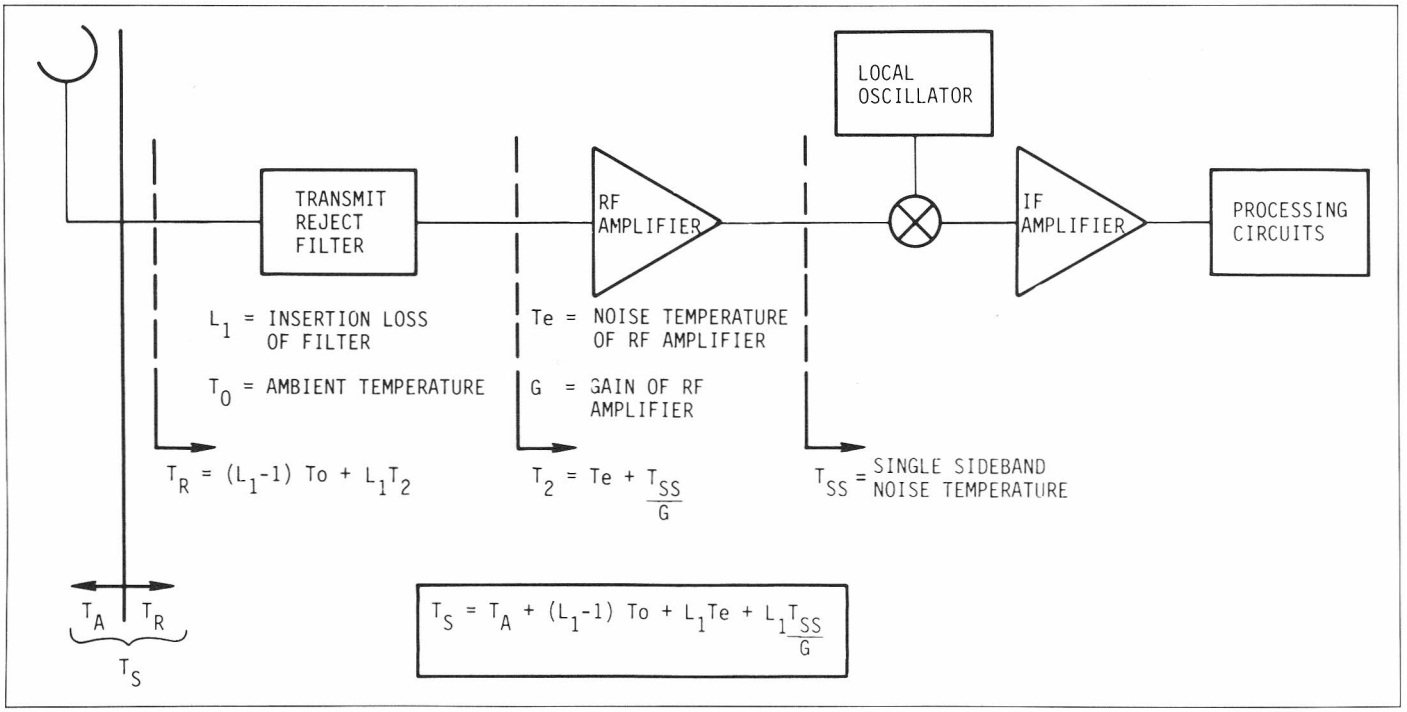

FIGURE 14. Simplified Block Diagram of Communications Receiving System

Understanding Noise (continued from page 36)

L_2 = atmospheric loss due to factors that are directly related to the characteristics of the atmosphere. These factors include rain, humidity, cloud cover and earth background noise.

k = Boltzmann's constant

B = system noise bandwidth in Hz

The only parameter under the full control of the system designer is the (G/T_s) of the system, where G is the gain of the antenna and T_s is the system operating noise temperature. Taking all factors into account, only (G/T_s) can be changed to achieve the required (C/N). Once this ratio has been determined, the system tradeoff between the gain of the antenna and the system operating noise temperature must be carefully considered to achieve the required (C/N) at the allocated cost. For example, for a fixed (G/T_s), is it more cost effective to increase the antenna size from 11 meters to 14 meters and use a less expensive receiver, or visa versa? This is the basic design problem facing systems engineers.

A similar gain/noise temperature budget analysis is used for radar and radiometer receiver system. The common element that determines the system sensitivity for each of these systems is the system operating noise temperature (T_s) which is the sum of the equivalent antenna temperature and the receiver noise temperature. The equivalent antenna noise temperature is determined primarily by sky noise, while the equivalent receiver noise temperature is generally detemined by the low noise RF amplifier or mixer/IF amplifier. Part II of this article will discuss some of these elements and in particular, the characteristics of RF amplifiers used in low noise systems, and how to choose the optimum low noise amplifier.

Understanding Noise — Part II

Part II of this article will cover phase and digital noise, and provide discussions on low noise system design involving thermal, phase and digital noise. A summary of low noise devices available today and in the future (1995) will be included.

Acknowledgements

The authors with to thank the following individuals for their contributions in the preparation of this article: Sam Petty of JPL; Klaus Breur, Ron Lange, Larry Oliva, John Pierro and David Wang of Eaton/AIL Division.

References

[1] World Distribution and Characteristics of Atmospheric Radio Noise CCIR Report 322, Geneve, Switzerland, 1963.

[2] J.B. Johnson, "Thermal Agitation of Electricity in Conductors" Phys. Rev., Vol. 32, pp. 97-109, July, 1928.

[3] H. Nyquist, "Thermal Agitation of Electricity in Conductors" Phys. Rev., Vol. 32, pp.. 110-113, July 1928.

[4] H.T. Friis, "Noise Figures of Radio Receivers" Proc. IRE, Vol. 32, pp. 419-422, July 1944.

[5] J.H. Frohmaier, "Noise Performance of a Three-Stage Microwave Receiver," Electronic Technology 37, pp. 245-246, 1960.

[6] James J. Whelehan, "Low Noise Millimeter Wave Receivers," IEEE Trans. MTT, Vol. MTT-25, No. 4, April 1977.

[7] R.H. Dickie, "The Measurement of Thermal Radiation at Microwave Frequencies," Rev. Sci. Instrum., Vol. 17, July 1946.

Henry C. Paczkowski received a BEE degree from the City College of New York and an MS (EE) degree from the Polytechnic Institute of New York and is presently deputy department head of the Receiver Systems and Technology Department at Eaton Corp., AIL Division. He joined the AIL Division in 1967 and is currently involved in directing the development of advanced microwave/mm-wave receivers, high technology components and associated technology that includes advancing the state of the art of broadband, low noise receivers.

Paczkowski is a member of the IEEE and has co-authored several papers covering low noise techniques and has served on several IEEE Microwave Symposium panels and workshops on microwave and mm-wave technology.

James Whelehan is the head of the Receiver Systems and Technology Department of the Advanced Technology Systems Division of Eaton Corp., AIL Division. He joined the AIL Division in 1959 and has been involved in the design and direction of state of the art low noise subsystems and components (i.e., parametric amplifiers, FET amplifiers, mixers) for both the microwave and mm-wave frequency bands.

Whelehan is a member of the IEEE MTT-S and is chairman of the Technical Committee on Microwave Low Noise. He has authored and co-authored numerous papers on low noise techniques and microwave mm-wave technology and holds three patents. He is also a member of Eta Kappa Nu.

1988 IEEE MTT-S International Microwave Symposium

May 25, 26, 27 New York, New York

Microwaves — Past, Present and Future

First Call for Papers

The 1988 IEEE-MTT-S International Symposium will be held in New York City, New York, on May 25, 26, and 27, 1988. To allow the presentation of papers in the format best suited to each, the program will consist of three categories of papers: full length, short, and open forum. Full length papers report results of significant advances in microwave technology. Short papers are typically a refinement in the state of the art. Open forum papers can combine qualities of the first two but allow for more informal technical interchange and for experimental demonstrations. The Technical Program Committee will try to abide by the preferences of authors but reserves the right to place the paper in the category it considers most appropriate.

Papers are solicited describing original work in the microwave field. A list of suggested topics is given below, but papers concerned with other aspects of microwave theory and techniques will be considered.

- Biological Effects and Medical Applications
- Computer Aided Design
- Solid State Devices and Circuits
- Microwave Systems
- Ferrite Devices
- Microwave Acoustics
- GaAs Monolithic Circuits
- Gigabit Signal Processing
- Lightwave Technology
- Low Noise Techniques
- Microwave and Millimeter Wave Integrated Circuits
- Communication Systems
- Field and Network Theory
- Passive Components
- Phased and Active Array Techniques
- Submillimeter Wave Techniques and Devices
- High Power Devices and Systems
- Measurement Theory and Techniques
- Manufacturing Methods

A prospective author is required to submit:

1. 15 copies of a 500-1000 word summary with supporting illustrations, which should include a concise statement of what is new and its potential application.
2. 10 copies of a 30-50 word abstract.
3. A separate sheet with the complete mailing address of the author and a statement categorizing the submitted paper as full length, short, or open forum. Submissions must be received by December 4, 1987. Late submissions will be returned unreviewed.

Mail Submissions to:

J. J. Taub/ J. J. Whelehan, Jr.
c/o LRW Associates
1218 Balfour Drive
Arnold, Maryland 21012

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First Call for Papers (continued from page 38)

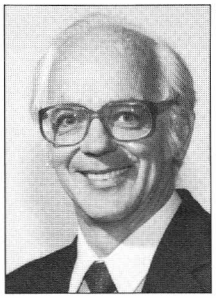
Authors will be notified of the status of their submissions by February 12, 1988. Authors of accepted papers will receive copyright release forms and instructions for publication and presentation.

The 1988 IEEE Microwave and Millimeter Wave Monolithic Circuits Symposium will be held in New York City, New York on May 24 and 25, 1988, in conjunction with the 1988 MTT-S International Microwave Symposium. *Do not submit the same material to both symposia.* These submissions should be sent to R. S. Kagiwaga, c/o LRW Associates, 1218 Balfour Drive, Arnold, Maryland 21012.

The 30th ARFTG Conference will be held in May in conjunction with the 1988 IEEE MTT-S International Microwave Symposium. ARFTG submissions should be sent to Mr. Raymond Tucker, Jr., RADC/RBCM, Griffiss Air Force Base, New York 13441. Contact Mr. Tucker for further information.

NOTE: Authors are cautioned to obtain all required company and government clearances prior to submittal. A statement signed by the authors stating that such clearances have been obtained must accompany the final manuscripts of accepted papers to be published in the Symposium Digest. These final manuscripts will be required in early March 1988.

THE 1988 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM



by Chuck Buntschuh

Microwaves: Past, Present and Future

The '88 International Microwave Symposium celebrates the Hertz Centennial, recognizes the advances of today, and looks ahead to the new challenges of tomorrow.

Microwaves: Past

We will celebrate the centennial of the public recognition of Heinrich Hertz's seminal work demonstrating the validity of Maxwell's theory in 1888. Maxwell had published a series of papers on electromagnetism and electromagnetic waves, starting in 1856 and culminating his *Treatise on Electricity and Magnetism* in 1873. Hertz had been keenly interested in Maxwell's theory as early as 1878, as a doctoral candidate under Herman Helmholtz. In 1879 Helmholtz tried to entice his protege into undertaking experiments to test the critical assumptions of Maxwell's theory. Hertz declined, however, because their laboratory was not suitable equipped and he felt it would take years to get satisfactory results.

However, shortly after joining the physics faculty at Karlsruhe, he found the induction coils he needed and began experiments in late 1886, in which he generated and detected electromagnetic waves. However, it was the two papers published in May of 1888, reporting on the velocity of propagation and reflection properties of the waves, that attracted international attention and led to the subsequent duplication of the work by others. It is thus particularly appropriate that we celebrate the Hertz Centennial and 100 years of microwaves and RF in May 1988 at the MTT Symposium.

We shall honor the occassion by mounting an exhibit of replicas of Hertz's experimental apparatus, on loan from the Science Museum of London, England. We will also have a special session in the technical program with four invited papers on the history of electromagnetics. John Bryant's article in this newsletter describes the exhibit and special session in some detail.

Microwaves: Present

Clearly the present state of the microwave art will be represented by all of the technical activities of microwave week: the MTT-S Symposium and Exhibition, the Monolithic Circuits Symposium, the ARFTG Conference, and the numerous workshops and panel sessions. There's not much more to add, except that we're expecting it to be a truly exhiliarating view of microwave achievement.

Microwaves: Future

Our plans for looking into the future of microwaves are still quite embryonic, and we are soliciting your contributions. We would like to have an exhibit, counterpoised to the Hertz exhibit, with displays depicting possible microwave applications in the next 20-50 years — things like satellite power stations, and gigabit computers come to mind.

It would also be interesting to have one or more talks on various aspects of the future of microwaves — applications, research directions, or microwave engineering as a career.

So, if you have any suggestions, or something you would like to contribute or organize, please give me a call. Let it be a bit off-the-wall, but do let me know and we'll work something out.

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1988 Microwave Symposium (continued from page 39)

Hertz's Key Papers on Electromagnetics

	Began Experiments	Submitted Manuscript	Published in Ann. D. Physik
1. On Very Rapid Electric Oscillators	13 Nov 88	23 Mar 87	15 May 87
2. On the Effect of Ultra-Violet Light Upon the Electrical Discharge	23 Mar 87	27 May 87	1 July 87
3. On the Action of Rectilinear Electric Oscillation upon a Neighboring Circuit			15 Mar 88
4. On Electromagnetic Fields Produced by Electrical Disturbances in Insulators	8 Sept 87	5 Nov 87	15 Apr 88
5. On the Finite Velocity of Propagation of Electromagnetic Actions	7 Nov 87	21 Jan 88	15 May 88
6. On Electromagnetic Waves in Air and Their Reflection	2 Mar 87	Apr 88	20 May 88
7. On the Forces of Electric Oscillations Treated According to Maxwell's Theory	6 Mar 88	Nov 88	15 Dec 88
8. On Electric Radiation	3 May 87	Dec 88	15 Feb 89
9. On the Propagation of Electric Waves by Means of Wires	7 Nov 87	Mar 89	15 June 89

HEINRICH HERTZ
1857—1894

PLANNING THE IEEE 1987 MTT-S HERTZ CENTENNIAL CELEBRATION

by J.H. Bryant
University of Michigan
Dept. of Elec. Engineering
and Computer Science
Ann Arbor, MI 48109-2122
(313) 663-4618

Background

The first century of microwaves began with the historic experiments of Heinrich R. Hertz at the Technical Institute of Karlsruhe, Germany starting November 13, 1886 and extending for three years. Using what is now called microwave circuits and techniques, his remarkably thorough investigations experimentally validated Maxwell's theory of electromagnetism, which had been propounded in 1864. He thus opened up the electromagnetic spectrum between DC and light for scientific and practical uses. Hertz's contributions in electromagnetics, comprising about 40 percent of his career output, were a step-by-step learning process alternating between experiments and analytical work.

It is planned to celebrate this work as a Hertz Centennial, starting at the 1988 IEEE MTT-S International Symposium on May 25-27, 1988 in New York City. Featured at the Symposium will be a session of four invited papers as a part of the Symposium technical program, and an exhibit of replicas of Hertz's experimental apparatus as a part of the MTT-S Historical Collection exhibit. The Hertz exhibit is to be continued at the MIT Museum, 265 Massachusetts Avenue, Cambridge, MA 02139, in the fall of 1988.

Exhibit Date, Schedule and Location

In considering what date might be most appropriate for the start of the celebration, three possible times came to mind: November 1886 (Hertz's first successful experiment to generate and detect electromagnetic waves), November 1887 (Hertz satisfied himself that he had validated Maxwell's theory), or May 20, 1888 (recognition by scientists in several countries and subsequent replication of Hertz's experiments). The latter date plus 100 years seems to be the most appropriate, and it falls in the week prior to the week of the 1988 MTT-S Symposium, to be held in New York.

In discussing the possibility of a display of Hertz's apparatus, it was noted that three days of showing seemed too short. One suggestion was to find a museum that would take the collection for a showing of two or three months afterward. A major consideration was that our exhibit is intended for the level of understanding and experience of our members, while most science museums today are limited to more general audiences. The MIT Museum is now scheduled to receive the collection for a showing in the fall of 1988. The only expense to MTT-S will be transportation and

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Centennial Celebration (continued from page 40)

local moving. To have the exhibit in a science museum will be a valuable privilege. It should afford the opportunity for meetings of the local MTT-S Chapter, other IEEE Society Chapters and other engineering groups, in addition to individual and group visits during regular museum hours.

At least one other museum has expressed interest in an additional exhibition. No planning has been done to date on that responsibility, which would require an extension of time on the loan of the items to be exhibited.

Artifacts

The Science Museum in London holds 20 replica items of Hertz's experimental apparatus used in his electromagnetics experiments. These replicas were procured in 1929 from a model maker in Munich who worked from the original apparatus which had been transferred to the Deutches Museum in Munich from Karlsruhe around 1908. It is proposed to exhibit them in the manner and in the order in which Hertz used them in his step-by-step discovery process.

Actually, not just one but three sets of replicas were fabricated by the model maker in Munich over half a century ago, for: (1) the Science Museum, London, (2) a museum in Berlin (status of the items not known at present) and (3) the Museum of Science and Industry in Chicago. The latter set was shown at the Chicago World's Fair in 1933. Only about half of the Chicago items survive, and some of them need extensive repair. We therefore plan to borrow the London Science Museum's set. Ted Saad recently visited the Science Museum and saw the pieces. Some of them need some refurbishing and the Museum is proceeding with that work at no cost to us. They will then photograph each piece for us, so that work on the exhibits catalog can proceed.

Certain other artifact replicas exist and it may be desirable to consider borrowing certain ones, or one or more of the Chicago pieces, to place near the registration area or in the industrial exhibit.

Exhibits Catalog

It is proposed to publish an exhibits catalog of some 40 to 50 pages, to be available for distribution at the Symposium and subsequent exhibits.

A photograph will be included of each item exhibited, along with a photograph of the corresponding original (available for about half of the items) to show the quality of the replicas. A copy of text and other illustrations in the exhibit, along with historical explanation, will be included so that the catalog can be distributed/sold as a monograph.

Exhibit Layout

The exhibit will consist of about 10 stations, each depicting a stage in Hertz's step-by-step discovery process. Each station will be illustrated with the apparatus arrange as much as possible as used by Hertz, and accompanied with text and graphics as appropriate. The items, in general, are rather large. The longest is 5 meters long and several are as much as 2 meters in height or length. It is estimated that about 2,500 square feet of floor space will be needed to accommodate the apparatus and to allow up to 50 people in the exhibit at any one time.

The Technical Session

A three-hour session of four invited papers is planned as a part of the 1988 MTT-S Symposium technical program.

1. *"The History of Electromagnetics as Hertz Would Have Known It,"* Professor Robert S. Elliott, University of California at Los Angeles.
2. *"Biography of Hertz,"* Professor Charles Susskind, University of California at Berkeley.
3. *"The Experiments and Supporting Analytical Work of Hertz in Electromagnetics,"* Professor John D. Kraus, Ohio State University.
4. *"The Fallout (Aftermath), Scientific and Practical."* Speaker to be announced.

It is planned to videotape this session for a permanent record, and to accompany the exhibit.

MTT EDUCATION COMMITTEE ANNOUNCES STUDENT PAPER CONTEST

The contest is to be among student-authored papers on projects and studies in areas normally included in **MTT Transactions.** Emphasis should be on originality and contribution to the state of the art.

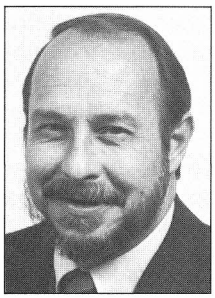
Local contests are to be held to select a winner for submission to the national contest where more than one paper is submitted. Prizes of up to $300 for local winners.

The national contest winner will receive a paid trip to the 1988 MTT-S Symposium where his/her paper will be presented. Papers will be due to the national contest office by December 1, 1987.

A formal announcement will be made on September 1. For further information contact:

Dr. John M. Owens
Electrical Engineering Department
University of Texas at Arlington
P.O. Box 19016
Arlington, Texas 76019
(817) 273-3496

1990 SYMPOSIUM



by John Wassel

MTT/AP Joint Hosts

The Dallas MTT-S Chapter is proud to have been chosen as host for the 1990 IEEE MTT-S International Microwave Symposium (IMS). After we were tentatively selected as the 1990 host at St. Louis in 1985, the Dallas AP-S Chapter approached our steering committee with a proposal to have a joint MTT-S/AP-S IMS for 1990. Since that time, we have been working on the issues involved in a joint symposium with both AP-S and MTT-S AdComs and we have now agreed in principle to co-host the 1990 IEEE MTT-S/AP-S International Microwave Symposium. This will be the first time since 1981 (Los Angeles) that AP-S and MTT-S have joined to co-host the IMS.

The advent of phased arrays and the gradual introduction of control elements into the radiating structures are examples where AP-S and MTT-S have converging technical areas of interest. The trend to an integration of monolithic circuits with the antenna structures will probably be accelerated over the next several years as monolithic technology matures. A whole spectrum of new and novel systems will be developed using these small cirtennas (circuit and antenna). These emerging developments will be the basis for our joint session with AP-S.

Dallas Chapter Activities

The MTT-S chapter in Dallas is very active and highly visible in the Dallas IEEE Section. Our MTT-S Chapter currently has 347 members, and the AP-S Chapter has 151 members. As a sample of the Dallas MIT activities this year, we had an EW applications mini-seminar, a radar mini-seminar, and will have a HEMT theory and applications seminar in the spring. Additionally, we had an Industry Night in the fall with exhibit booths (staffed by the local microwave reps) which helped to raise money to finance the mini-seminars. Our last meeting in May is committed to a preview of papers that will be presented by local microwave people at the IMS which is a good way to recognize their contributions.

Dallas is a regional marketing center noted for its convention facilities and capable of accommodating some of the largest events such as the 1984 Republican Convention. Dallas-Fort Worth (DFW) is the ninth largest metroplex in the United States and has the fourth largest concentration of high technology firms, over 800. We are centrally located between the east and west coast with easy access by air.

Site Location, Hotels, Dates

The IMS will be in the West Hall of the Dallas Convention Center. The top floor has over 100,000 sq. ft. of exhibit area and four large ballrooms which will be used as the MTT-S meeting area. The bottom portion of the West Hall is earmarked for AP-S events and the registration area. The West Hall will be closed off from the rest of the Dallas Convention Center during the Symposium; traffic will be limited to IMS attendees.

The Headquarter hotels will be the Hyatt Regency for MTT-S (site of the 1982 IMS) and the downtown Dallas Hilton for AP-S. These hotels are located about one mile apart so buses will be used for transportation between sites. Since 1982, the West End Historical District has finally been developed with fine restaurants and a Festival Market Center which has helped to promote good evening activities. The West End is just north of the Hyatt Regency within easy walking distance.

The IMS will be the week of May 6-12, 1990 at the West Hall of the Dallas Convention Center. This is about a month earlier for IMS than we have been used to. The Technical Program Committee will have to meet early in January so we meet all the deadlines for publications, advance programs, and other arrangements. With careful planning, we are confident that the 1990 IMS will be one of the best ever.

THE FIRST CENTURY OF MICROWAVES 1886 to 1986

by John H. Bryant

DISTINGUISHED MICROWAVE LECTURER (1986/1987)

Being an MTT-S Lecturer this year has been a rewarding experience. Renewing acquaintances and making new ones has created opportunities to meet people with historical information and know-how, some with artifacts to contribute to the MTT-S Historical Collection.

My special thanks go to the MTT-S Chapter officers, members and friends whose hospitality, arrangements and communication have enabled me to get to every scheduled meeting, and to always have use of facilities needed.

I trust that my efforts are fostering a greater interest in the history of our field and greater awareness of the need to preserve it.

GALLIUM ARSENIDE — KEY TO MODERN MICROWAVE TECHNOLOGY

by Edward C. Niehenke

DISTINGUISHED MICROWAVE LECTURER (1986/1987)

It has been a pleasure presenting my lecture "Gallium Arsenide — Key to Modern Microwave Technology" to the many IEEE MTT-S Chapters and groups. I am honored to be selected to represent IEEE MTT-S and have thoroughly enjoyed lecturing to 40 groups and meeting 1459 people attending the lectures as of this writing. When you read this article, I will have lectured to another 15 groups in the northeast corridor of the U.S. and will have given a total of 55 lectures. I plan to give lectures at Rio de Janeiro this summer and to Japan this fall to complete my lecture schedule.

I want to thank personally the various MTT chapter chairman and other hosts for the hospitality, assistance and cordiality extended to me. When I reflect on the last six months, I have many wonderful memories of all the fine people I met and the enjoyable experiences of presenting the lecture. These factors block out remembrances of the hectic traveling schedule.

Since my last report, I completed lecturing to the Western portion of the U.S. visiting MTT-S Chapters in Denver, Los Angeles, Santa Clara/San Francisco, Seattle, Portland and Tucson. While in the many localities, I visited the National Bureau of Standards in Boulder; Hughes and TRW in Los Angeles; Avantek and Gould/Dexcel in the San Francisco area; Boeing at Seattle; Tektronix, TriQuint, United Epitaxial Technology and the Oregon Graduate Center in Beaverton, Oregon. At the many facilities, extensive development is being done in the gallium arsenide area.

While at NBS, I found very interesting the fact that the Josephson Junction is used as a voltage standard. With the application of a 96 GHz signal to many thousands of these junctions in series, a precise quantum voltage is summed to obtain a 1 volt standard. They also use the six port measurement technique for calibration of noise and power measurement standards. At the Boeing facility, I saw the 747 and 757 airplanes being assembled and also visited their High Tech Center. I now have a great appreciation of the technology and labor that goes into the manufacture of one of these planes. At the High Tech Center they are exploring the design and use of GaAs MMICs using foundries. They are also performing research on the use of optical circuits and optical fiber for transmitting control signals from the cockpit to the various parts of the airplane. A mechanical cable is presently used for this function.

The Beaverton area is full of high tech companies. At the Oregon Graduate Center they are performing material studies not only of the III-V group containing compounds as GaAs, AlGaAs, InP and InGaAs, but also the II-VI group. Deep Level Transient Spectroscopy (DLTS) is being used to evaluate and study defects in semiconductor substrates. Tektronix engineers are performing research on the heterostructure bipolar transistor using AlGaAs and GaAs. This bipolar transistor offers an order of magnitude greater transconductance as well as a higher power capability compared to the GaAs FET. The TriQuint facility is busy making numerous FET circuits using 1 and 0.5 micron gate length technology. They are investigating 0.25 micron gate length MMIC technology for the future. United Epitaxial Technology is actively processing epitaxial layers on substrates. This facility as well as many others I have recently visited, uses Metal Organic Chemical Vapor Deposition (MOCVD) reactors to form the epitaxial layer.

In California, Gould/Dexcel is busy making FETs and FET circuits as well as developing new processes for advanced FET devices. Avantek is heavily involved in the manufacture and development of MMICs as well as fabrication of 2 micron emitter pitch silicon bipolar transistors operational to 20 GHz. The specific facilities at TRW and Hughes that I visited were actively performing research and producing microwave circuits and devices from frequencies in the microwave region to millimeter wave bands.

I have been very lucky so far in missing only one lecture. I was not able to make the IEEE Tucson Section noon lecture at Fort Huachucha due to problems with the aircraft, but was able to make the evening MTT meeting. My apologies to the IEEE Section attendees. As soon as this problem surfaced, I immediately called Howard Kohlbacher, who was in charge of organizing this meeting. Howard was very understanding and immediately came up with an alternate program for the Section.

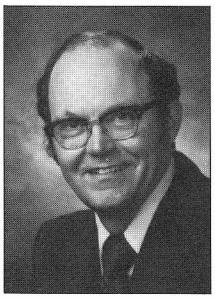
It has been a most satisfying year for me and I look forward to lecturing to the remaining groups.

IRS LOSES. *Donna Todd filed a completely accurate tax return but added a note saying she had signed it involuntarily under the penalties of an unfair tax law. The IRS fined her $500 for filing a frivolous return. When she refused to pay the fine, the IRS attached her bank account and put a lien on her property. Donna sued, and IRS attorneys quickly agreed to drop the penalty, release the liens and pay her lawyer bills. But Donna wanted more. She sued the agents involved* personally. *They protested.*

Court's opinion: "...such a cavalier attitude towards citizens of this country by a government agency will not *be tolerated." Donna* can *sue.*

Donna L. Todd, D. Mont., No. CV-84-105-BLG.

PCs FOR ~~AP~~ MTT



by E.K. Miller
Electrical and Computer Engineering Department
University of Kansas
Nichols Hall
Lawrence, KS 66045

Edmund K. Miller received his PhD in 1965 in electrical engineering from the University of Michigan, and is currently a Professor in the Department of Electrical and Computer Engineering at the University of Kansas. His involvement in computational electromagnetics began during his dissertation work at UM and has continued ever since. He acquired his first personal computer, a Commodore PET, in 1977, then subsequently moved on to an Apple II, and most recently a Macintosh. His column "PCs for AP" in the AP-S Newsletter began in 1984 as a result of presenting an URSI paper "PC Applications in Electromagnetics." Because of a mutual interest in PC applications among other IEEE societies, he has offered to provide this column on a trial basis to the MTT-S Newsletter also. He welcomes your suggestions and material for possible inclusion in future columns.

I've finally gotten my hands on a Laser printer, in this case the LaserWriter from Apple. The quality and speed of such pieces of hardware continually amaze me, especially as I think back a few years over the evolution of such devices. When I got my first PC, the Commodore PET, I was able to accomplish useful work (to me) without benefit of a printer at all. My mode then was to copy by hand the screensful of data that were produced by some monte-carlo experiments being conducted with Prony's Method(!). Because the computer wasn't all that fast and had only 8K memory besides, that approach wasn't particularly burdensome. When I subsequently obtained an Apple II and added a printer as well, even though this was only a thermal printer, the improvement was almost spectacular, especially since I could also dump screen graphics. Then along came the Macintosh and my first excursion into word processing using the dot-matrix ImageWriter printer. To say that this has greatly changed my work style would be an understatement, as I am able to produce all of my correspondence and technical documents, besides doing numerical analysis and graphics. But the laser printer represents still another generation of evolution, bringing near-typeset quality to desktop publishing. One next logical step would be color hardcopy output, and beyond that sound, movies, simulated three-dimensional imagery,...!

Book Review Note

Two columns ago, I "mini-reviewed" several books dealing with numerical analysis, PC applications, etc. As one source of the book *Numerical Recipes*, I mentioned the Library of Computer and Information Sciences (LCIS) but neglected to provide their address, an omission that several readers pointed out. Advertisements for this book club can be found in various magazines, or you can write to P.O. Box 1010, Riverside, NJ 08370-1010. I should emphasize that because this is a book club, you must be a member to purchase books at their (usually) special prices. As an alternative for *Numerical Recipes*, you might contact Cambridge University Press, 32 East 57th Street, New York, NY 10022, or call (800) 431-1580 (outside New York State and Canada), where you can use a Visa or MasterCard for payment. Please note that although I belong to LCIS, I am not making a particular recommendation for it or any book club. I mention it only because it represents one source of discounted scientific/technical books that might be of potential interest to you.

I must also express my thanks to Ray Rosich of Littleton, CO for sending me information concerning several interesting books including a full-page ad for Cambridge U. Press on page 112 of the June 1986 issue of Physics Today in which *Numerical Recipes* was described. If any of you have come across similar books that you think readers of this column might enjoy, I'd appreciate your sending me your comments and suggestions.

In this connection, I'll list here a number of books that are computationally or modeling oriented that I have seen advertised, listed and/or reviewed in various sources such as Science magazine, Byte, Physics Today, IEEE Spectrum, etc. I realize that not all are devoted to AP-S topics, but the general topics sound interesting to me and might have some relevance to the overall theme of computer modeling. Asterisks denote books I already have and will review in future columns, while the others might also be reviewed or summarized as seems appropriate. For now, I'll just provide names, authors and publishers.

Computer Simulation Methods in Theoretical Physics, by D.W. Heermann, Springer-Verlag, New York, 1986, $29.00.

Computational Heat Transfer, by Y. Jaluria and K.E. Torrance, Hemisphere, NY, 1986, $49.00

The Recursive Universe, by W. Poundstone, William Morrow, 1985, $19.95.

Computer Modeling of Complex Biological Systems, edited by S.S. Iyengar, CRC Press, Boca Raton, FL, $59.00.

The Computer Modeling of Mathematical Reasoning, by A. Bundy, Academic Press, Orlando, FL, 1985, $35.00.

Computers in Mathematics, edited by D.H. Ahl, Creative Computing Press, $15.95.

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PCs for MTT (continued from page 44)

Numerical Methods in Engineering Practice and *Computerized Numerical Analysis*, by A.W. Al-Khafaji and J.R. Tooley, Holt, Rinehart and Winston, New York.

Differential and Difference Equations Through Computer Experiments, by H. Kocak, Springer-Verlag, New York, 1986, $44.00 including disk.*

Numerical Methods in Fluid Dynamics, edited by F. Brezzi, Springer-Verlag, New York, 1985, $20.50.

Optimization Using Personal Computers, by T.R. Cuthbert, John Wiley and Sons, New York, 1987.*

Computational Methods for Kinetic Models of Magnetically Confined Plasmas, by J. Killeen, G.D. Kerbel, M.G. McCoy and A.A. Mirlin, Springer-Verlag, New York, 1986, $38.00.

MathWriter

As an update on another topic touched on in a recent column, that of producing the equations needed in scientific/technical word processing, I'll briefly summarize my initial impressions of MathWriter for the Macintosh. This is a product available from Cooke Publications, P.O. Box 4448, Ithaca, NY 14852 for $49.95. This is a WYSIWYG (what you see is what you get) editor for writing equations whose design philosophy of point-and-click is well suited to someone like me who might use such a tool infrequently enough have difficulty memorizing and remembering a large collection of embedded commands.

MathWriter interfaces with other Macintosh word processing software so that importing equations into a test document is straightforward. It provides a variety of options, for example the stretching or shrinking of an equation to fit available space while maintaining the width-to-height ratio even after pasting the equation into a document. An overlay screen is also available to manually handle superposition of multiple characters. Some special characters are always on screen such as integral, summation and product signs, while others are available either from a pull-down menu or a user-defined, on-screen palette. Automatic alignment of fractions and matrices is possible, and the program also automatically and retroactively adjusts in size the parenthesis, bracket, or brace which preceeds and follows a fraction.

As a demonstration of the kinds of equations the MathWriter produces, I include two examples below:

$$V = \sum_{m=1}^{m=\infty} \sum_{n=1}^{n=\infty} A_{m,n} \sqrt{\frac{\sinh \pi (c-z) \sqrt{\frac{m^2}{a^2} + \frac{n^2}{b^2}}}{\sinh \pi c \sqrt{\frac{m^2}{a^2} + \frac{n^2}{b^2}}}} \sin \frac{m\pi x}{a} \sin \frac{n\pi y}{b}$$

$$J_\nu(z) = \left(\frac{z}{2}\right)^\nu \sum_{\kappa=0}^{\infty} \frac{(-z^2/4)^\kappa}{\kappa!\ \Gamma(\nu+\kappa+1)}$$

An interesting feature of MathWriter is that a library of equations can be created and stored in a data base for later access and use in document preparation. Switcher™ is also provided with the program to permit convenient "real-time" operation. While I have just received this program and don't have much experience using it so far, I expect it to be a real asset creating future, equation-laden, documents.

Radio System Design Tools

John Murray of John Murray Associates, 1823 Folsom Street, Suite 201, Boulder, CO 80302, (303) 444-4874, has informed me of a family of radio-system design tools he's developed for IBM PCs and compatibles. These are available in two packages, *Radio Design Utilities (RDU)* and *Radio Systems Planning Techniques (RSPT).* In the former is included a set of tools that provides many of the formulas and constants needed for routine radio-design calculations. For example, conversion among the various popular units for field strength, power density, received power, noise levels, etc. are included. Among the calculations/formulas are contained free-space path loss and range, Gaussian and Rayleigh statistics, satellite links, great-circle range-bearing, and channel loading. The user interface includes default data, screen graphic displays and fully buffered and error-checked input. Extensive prompts and help messages also assist in interpreting input data requirements and results.

RSPT embodies an integrated set of planning and design capabilities for VHF and UHF frequencies. Included in its set of tools is path analysis for both discrete- and nominal/statistical-terrain models, where the former contains digital topographic data files for the coterminous United States. Other options in RSPT are coverage analysis, cosite analysis and frequency assignment. The program evaluates the RF path between transmitter output and receiver input, with median received signal level and signal variability determined by considering transmitter and receiver characterstics, siting information and intervening terrain and atmospheric factors. Transmission loss is computed using a series of propagation models chosen to best serve specific applications, with the primary one being the Irregular Terrain Model developed at the Institute for Telecommunications Sciences. For prices and further information, contact John Murray. Computer requirements are an IBM PC/XT/AT compatible, color-graphics adapter with single-color monitor, 512K minimum memory, with a 20M hard disk and math coprocessor (8087 or 80287) recommended. John has indicated his willingness to make special arrangements for using these programs in educational applications.

Drafix 1

Another program that I thought would be worth mentioning, this time for IBM PCs and compatibles, is *Drafix 1*, a computer-aided 2D design and drafting (CAD) program that has drawn rave reviews from PC Magazine (September 16, 1986). This program is

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PCs for MTT (continued from page 45)

available for $295 from Foresight Resources Corp., 932 Massachusetts, Lawrence, KS 66044-2868, (913) 841-1121. I was first made aware of *Drafix 1* by a student in my graphics class who works part-time for Foresight and arranged a class demonstration. It requires 512K RAM (640K preferred), mouse or digitizer, and DOS 2.1 or later, and works with CGA, EGA, Hercules, Sigma 400, Conographics 40, Techmar Graphics Master, and AT&T PC graphics cards, with the 8087/80287 being optional.

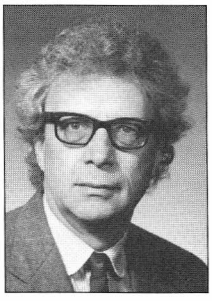
The user interface is claimed by the reviewer Glenn Hart, from whose PC review this summary is excerpted, to be "perhaps the best on *any* CAD" package. It features a sort of Macintosh-mutant approach using a hierarchical menu structure where the lower levels are always visible in a thin strip below the higher levels. Image manipulation includes features such as zoom, pan, redraw and up to eight numbered views of an image can be saved and recalled instantly. Besides drawing lines, arcs, circles and such, *Drafix 1* draws parallel lines having variable width and offset, perpendiculars and parallels to existing lines, and tangents to one or two circles. Boxes and polygons can be drawn, filled with color and exploded into segments. Hart concludes his review by observing "all serious CAD users will find that *Drafix 1* offers incredible performance for the price." Foresight Resources does provide an interface to other engineering modeling programs so that preparation of the input data needed for the latter might be accomplished using *Drafix 1*. A program such as this might have possibilities for inputting EM models as well.

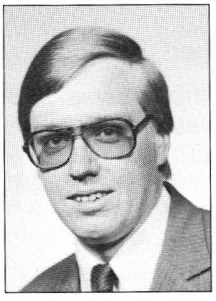
Real-Time Presentation Graphics

If you give demonstrations using a computer to audiences of more than a few people and don't have a projection TV or multiple monitors, you might want to consider *Kodak Datashow* or similar products. The unit consists of a liquid-crystal display (LCD) panel which generates projectable dark-blue-on-light-grey-background images when linked by one cable to the color graphics adapter RGB port of CGA-compatible RGB port of a host IBM PC or compatible. A hand-held wireless remote controller enables walk-around operation so that graphics or other screen images can be selected and displayed as desired. Other features are also provided such as split-screen images, image reversal, highlighting, adjustable screen contrast and an electronic pointer. In operation, the LCD projection pad is placed on an overhead projector in the manner as a transparency, which the LCD image resembles.

Using either presentation images prepared beforehand, or images which demonstrate the real-time operation of demonstration software, the *Datashow* system represents the first phase of the electronic transparency. If true color eventually follows and the resolution increases beyond the 640 x 200 now offered, these units also offer competition to projection TVs for various purposes. The base price of a single unit is $1,270 and educational discounts are available through Pacific Crest Software, Inc., 887 N.W. Grant Avenue, Corvallis, OR 97330, (503) 754-1067. I've seen a *Datashow* demonstrated, and agree with Jerry Pournell of *Inforworld* that "this product is going to have one mighty effect on education, starting with science and engineering, and then everywhere else."

MEMBERSHIP SERVICES





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

MTT-S Ranks Second in Membership Growth

Since the end of 1986, the MTT Society has improved its rank in growth rate from fifth to second place among the 33 IEEE Societies. At the end of February 1987, the membership was 8,234 and the growth rate over the last twelve months was 10.7%. This compares favorably with an increase of 2.7% averaged over all IEEE Societies. With a continuing effort in recruiting new members, we should be able to reach the 10,000 membership mark in late 1987.

The four chapters which showed very high growth rates in 1986 were Baltimore (58%), the India Council (70%), Schenectady (63%) and West Germany (21%). Representatives from these chapters will receive a plaque and $200 at the 1987 International Microwave Symposium in recognition for their successful membership drive efforts. The major growth in membership in 1986 occured in areas which have a chapter. The average growth in chapter membership was 9.7% in the USA and 20.8% overseas.

Distinguished Microwave Lecturers

The 1986/87 Distinguished Lecturers gave talks to most of our chapters in the USA and overseas. Ed Niehenke gave 40 lectures on "Gallium Arsenide, Key to Modern Microwave Technology" and John Bryant presented 36 talks on "The First Century of Microwaves 1886-1986."

The new 1987/88 Distinguished Microwave Lecturers have already received a number of requests to visit chapters and address topics which are of interest to many MTT members. Dave Barton will lecture on "Technology Trends in Microwave Radar" and Rolf Jansen will present talks on "CAD of Hybrid and

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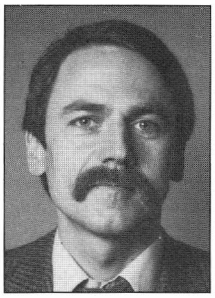
CAD OF HYBRID AND MONOLITHIC MICROWAVE & MILLIMETER-WAVE MMICs



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 (1987/88)

Abstract

With the availability of transistors having useful gain in the MM-wave range and the advanced development of GaAs monolithic MICs in the last five years, demand for accurate and reliable CAD up to highest frequencies is growing. The economic design of MMICs without CAD is simply impossible. Yet the development of sophisticated computer-aided design tools is far behind the pace of technology and the needs arising thereof, similarly as in the early days of silicon ICs. With today's advanced technologies having complex metallization schemes, multilayer dielectrics and submicron devices, it is necessary to employ improved component modules and CAD strategies to ensure first design iteration success as far as possible. In view of this, engineering workstations are under development which will finally close the gap between standard technology processes and CAD as well as eventually merge silicon and GaAs design techniques.

The electrical phenomena which complicate the design of MICs into the MM-wave range will be discussed in relation to technological and economic requirements. Also, an overview on existing CAD packages and their specific features will be given. This includes the first commercial solutions representing essentially extensions from the electronic circuit domain as well as a variety of less-known dedicated microwave packages with particular stress put on developments made in Europe. The discussion addresses linear and non-linear CAD and the advantages and shortcomings of frequency-domain and time-domain analysis. Out of more than 10 years of professional experience in the computer-aided design and realization of MICs, a judgement of the existing solutions and concepts will be attempted. A process-independent design and layout engineering workstation system as it is presently configured in one of Europe's most progressive GaAs MIC companies will be described. The lecture will be concluded by a demonstration of various MMIC designs and the latest techniques used to simulate the respective circuits and verify new modeling approaches and CAD strategies.

TECHNICAL COMMITTEES CHAIRMAN REPORT

by Reynold Kagiwada

The Technical Committees play an important role for the MTT Society. They serve as the technical expertise for various disciplines germane to the MTT-S membership. For a highly technical organization like MTT-S, this is a very important function. These committees are our Society's resources and provide various services. They can be called upon to help arrange speakers for local chapters. They are actively involved in the MTT-S International Microwave Symposium, Microwave and Millimeter-Wave Monolithic Circuits Symposium, and various other symposiums. They organize workshops for our symposium and have helped solicit survey articles for the MTT-S transactions. The Technical Committees Chairmen are listed in the 1987 MTT-S Committee Directory; a change since publication is the chairman of MTT-2:

MTT-2 Microwave Acoustics

T.J. Lukaszek
U.S. Army LABCOM
ET&D Lab
SLCET-MA-A
Hexagon Building
Fort Monmouth, NJ 07703-5000
(201) 544-2751

The Technical Committees are formed to serve the membership of MTT-S. Please feel free to contact the various committee chairmen. If you have any comments with regard to the committees, I would be happy to hear from you. My address is:

R.S. Kagiwada
TRW, ESG
R6/1106
One Space Park
Redondo Beach, CA 90278
(213) 535-5515

TAB HIGHLIGHTS

by David N. McQuiddy, Jr.

The Technical Activities Board (TAB) is a major board of IEEE charged with planning and implementing the technical activities of IEEE. The President of MTT-S is a voting member of TAB and one of his duties is to represent MTT-S at the three TAB meetings held during the year. I was delegated by Reinhard Knerr to represent him at the third 1986 meeting held in New Orleans on November 20-21, 1986.

The first meeting on Thursday, November 20, was devoted to the TAB Orientation and Management seminar for Society/Council Officers. This meeting lasted from 8:30 a.m. to 5:00 p.m. and provided a good overview of the duties of society officers and the various services that IEEE Headquarters will provide. In addition, there were sessions to help the new Society Officers in dealing with their responsibilities and needs.

President's Forum

The second meeting, the President's Forum, was held that evening from 8:00 p.m. until 11:00 p.m. to discuss topics prior to the more formal TAB meeting to be held the next day. The informal setting allowed for debate of the significantly important TAB items. This meeting is well worth attending because it provides valuable insight into the problems and concerns of our sister Societies and allows the Society Presidents an opportunity to reach a supportable position for voting purposes at the TAB meeting. Several of the topics that were discussed at this meeting are listed below:

- The algorithm that Headquarters uses to compute the rebate the Societies receive from the All Transaction Package will be changed for 1988. Societies with a low non-member subscription rate could lose income.
- Headquarters has not been effective in the collection of voluntary page charges and charges for overlength papers. This is causing some Societies a financial burden. A motion was formulated for presentation at the TAB meeting. The motion passed and now the Societies can expect to receive income in a more timely manner.
- A proposed revision to the IEEE Policy and Procedures manual was discussed. The revision deals with and attempts to clarify the joint issue/multiple publication position held by Headquarters. Questions were raised concerning whether this was a real problem; however, a unanimous position was not forthcoming and the revision passed the next day at the TAB meeting.

TAB Meeting

The TAB meeting was held on Friday, November 21, from 9:15 a.m. until 5:00 p.m. I have summarized several items of general interest to us below:

- A proposal to establish an IEEE Field Award in the area of Industrial Systems Engineering was approved.
- A motion was passed to contribute $40,000 (our share will be approximately $1,000) as a one time funding to endow the IEEE Richard M. Emberson Technical Service Award.
- A proposal to createa Judith A. Resnik Space Engineering Field Award was approved.
- Motions were made to withdraw the IEEE Position Papers on Engineering Technology and on Engineering Education in the United States. Both motions were rejected.

The TAB meetings are essential to the vitality, not only of MTT-S, but also for IEEE. TAB serves as a forum for us, as professionals, to deal with common issues and concerns to our societies and to formulate long range solutions to keep us healthy. I'm enjoying my participation in this process and will do my best to contribute in future sessions.

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LONG ISLAND MTT CHAPTER SYMPOSIUM

COMPUTER-AIDED ENGINEERING, DESIGN, MANUFACTURING AND TEST

The Long Island Chapter of the MTT will hold its annual Symposium on April 28, 1987 at the Crest Hollow Country Club, Woodbury, New York. This year's Symposium is devoted to the timely and dynamic topic of Computer-Aided Engineering, Design, Manufacturing and Test.

Until the advent of CAD, engineers and managers accepted costly cut-and-try methods and the iterative process as the reality of microwave design. Present CAD tools have certainly eliminated much of this guesswork and inefficiency but major advancements still must be made if we are to produce affordable products in a timely manner which deliver performance at the right price.

The success of the half-billion dollar DOD MIMIC initiative is heavily dependent on dramatic advancements in CAD tools since the iterative process in MMIC has a price tag which few can afford and is one of the major deterrents to affordable MMIC products. Needless to say the cut-and-try methods of the past have no place (even if we were foolish enough to consider them) in a future dominated by "untweakable MMICs."

Automation will not only play a major role in the design of a product but will be a dominant force in every phase of its production. The vision of a microwave engineer producing a design at a work station which, through a network analyzer, collects and stores passive and active element data and performs parameter extraction, which performs synthesis, performs small and large signal simulations to assess performance before the prototype is built, assists in the layout of the substrate, performs design rule checks, factors in proximity effects and produces a tape which directs a plotter to produce the Rubylith, generates a part list, and which is linked via a database to an ATE that test the circuit so it can analyze test data and, through the designer, make changes to the design, or manufacturing process to maximize yield or performance — will this ever be a reality?

If what has happened in VHSIC and the auto industry is any guide, the answer is emphatically yes, but it may take a national commitment with government, industry and our universities joining together and working toward this goal.

Our Symposium will touch on:

- Latest developments in commercial CAD software
- Non-linear and linear modeling
- De-embedding
- Work stations
- Network synthesis
- Computer-aided manufacturing
- Standardized ATE languages

Our first rate roster of speakers includes:

V.C. Gupta	University of Colorado
W. Curtice	RCA
S.E. Sussman-Fort	SUNY, Stony Brook
R.Q. Lane	CEL
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
B. Walker	Systron Donner

Running concurrently with this first quality Symposium will be nearly 60 exhibits of the latest in microwave CAE workstations, CAD software, probers, instrumentation, devices and components.

L.I. SYMPOSIUM INFORMATION

- 12 Distinguished Speakers
- Keynote Speaker: Dr. K.C. Gupta
- Microwave Show with 60 Exhibitors
- Digest of Papers
- Refreshments & Hot Buffet Luncheon
- Door Prizes

Location: Crest Hollow Country Club
8325 Jericho Turnpike (Rte. 25)
Woodbury, New York
(516) 692-8000

Date: April 28, 1987

Time: 8:00 a.m. to 7:00 p.m.

Information: Bob Koelzer
Narda Microwave Corp.
435 Moreland Road
Hauppauge, New York 11788
(516) 231-1700, X309

Registration Information

IEEE Member.....$40.00
(includes lunch, refreshments, 1 Digest)

Non-Member.....$50.00
(includes lunch, refreshments, 1 Digest)

Full-Time Students.....$25.00
(must present college I.D.)

Extra Digests.....$12.00

Directions

Eastbound from Brooklyn, Queens, Manhattan
Westbound from Eastern Long Island

Southern State Parkway — Exit 28A N
Northern State Parkway — Exit 36B N
L.I. Expressway (Rte. 495) — Exit 44N

to

Seaford-Oyster Bay Expressway (Route 135) Northbound to (Woodbury East) exit leaves you on Jericho Tpk. going East 1½ miles to Crest Hollow on left hand side of road.

1987 LONG ISLAND MTT SYMPOSIUM ADVANCE PROGRAM — APRIL 28, 1987

TU1 Symposium Opening (9:00 a.m.)

TU2 A Futuristic Vision of Microwave/Millimeter Wave Computer-Aided Design (9:05 a.m.)

K.C. Gupta, Dept. of Electrical and Computer Engineering, University of Colorado, Boulder, CO

Recent advances in, and practical systems applications of, monolithic microwave/mmwave technology pose a challenge to the development of CAD tools. Increased complexities of MMICs and prohibitive cost of experimental iterations in monolithic fabrication have created an urgent need for the next generation of CAD techniques.

Models with vastly improved accuracy, nonlinear circuit analysis techniques and integrated CAD-CAM systems are envisioned in the near future.

TU3 GaAs MESFET Modeling & Nonlinear CAD (9:35 a.m.)

Walter R. Curtice, Microwave Technology Ctr., RCA Labs, Princeton, NJ

Small-signal GaAs MESFET models for microwave circuit design software will be discussed with emphasis on the model calibration process. A drawback of most current large-signal models is that they involve too much computational time to be useful for design work. A technique of large-signal analysis, the harmonic balance method, will be discussed which takes advantage of the efficiency of frequency domain circuit analysis while retaining the physical reality of time-domain simulation of the nonlinear MESFET model. N-FET, a harmonic balance CAD program for large-signal MESFET amplifier design, will be discussed and shown to be an accurate design tool.

TU4 Computer-Aided Matching Network Synthesis (10:10 a.m.)

Stephen E. Sussman-Fort, Dept. of Electrical Engineering, State University of New York, Stony Brook, New York 11794-2350

The current methods of computer-assisted matching network design, including the sloped-approximation/synthesis method and the real-frequency technique will be reviewed. Novel design approaches as well as some unanswered questions concerning the best network structure to use for broadband matching will be discussed.

TU5 TECAP — A Nonlinear Device Modeling Program that Can Shorten Microwave IC Design Times (10:40 a.m.)

Dennis Poulin, Hewlett Packard

HP TECAP (Transistor Electrical Characterization and Analysis Program) which provides a fast, easy to use method of obtaining nonlinear SPICE models based on DC, CV and S-parameter measurements will be described. TECAP takes all the measurement, simulation, parameter iteration and optimization steps used to arrive at a nonlinear device model and puts it all in one package. SPICE-compatible models can be determined in a matter of hours instead of weeks.

TU6 De-embedding & Characterization of Two-Ports (11:00 a.m.)

Richard Q. Lane, California Eastern Labs., Inc. Santa Clara, CA

De-embedding techniques that are in use both at CEL and several other laboratories will be discussed. The strengths and weaknesses of the different methods based on practical experience will be reported and sufficient references will be given to enable the user to pick the method best suited to his application. A novel program to measure noise and gain parameters will also be described.

TU7 Time-Domain Analysis of Microwave Circuits (11:30 a.m.)

Harold E. Stinehelfer, Made-It Associates, Burlington, MA

The conversion of measured frequency-domain data to the time-domain will be discussed. The analysis of the reflection time domain into an equivalent circuit will be used to describe junction effects. The de-embedding of desired circuits from their fixture will be illustrated. The accuracy enhancement using this technology will be emphasized.

Lunch (12:00-1:30 p.m.)

Exhibits Open (12:00 Noon)

TU8 Develop a More Accurate MMIC Database

Eric Strid, Cascade Microtech, Inc., P.O. Box 1589, Beaverton, OR

The design and manufacture of untweekable MMICs requires accurate and continuous characterization of FETs and other circuit elements. This paper will describe some recently developed techniques for verifying on-wafer microwave calibrations and measurements, quick, automatic methods of extracting FET equivalent circuits, and analyzing the resulting mountain of data.

TU9 A Survey of Microwave CAE Technology (2:00 p.m.)

James Fitzpatrick, Hewlett Packard, Santa Rosa, CA

Present software solutions to improve microwave design, engineering productivity including modeling, parameter extraction, synthesis, simulation substrate and mechanical layout, yield prediction and test will be reviewed. Advancements expected in software technology in these areas over the next three years will be discussed.

TU10 Improving Microwave Circuit Production Yields Through the Use of Computer-Based Testing & Manufacturing (2:30 p.m.)

William Childs, EEsof, Inc., Westlake Village, CA

Powerful technological forces are converging that will result in a transformation of the engineering methodology of the microwave industry. GaAs foundry capabilities have become widely available — either as in-house services or as true commercial foundry services made available to outside designers. The production capacities of these foundries are enormous and along with significant market forces requiring these kinds of capacities, more and more designs will be performed for MMIC realizations.

In this same period, the price-to-performance ratio of computers and workstations is taking a jump downward. Both the microwave CAE supplier and the end-user can look forward to cost-effective computer hardware for analog MMIC design tasks.

EEsof's development planning has always focused on integrated product suited to address analysis, design, layout and testing of microwave circuits with new developments in these areas for subsystems and system application.

TU11 The Design of a Wideband Amplifier with Large Dynamic Range and Low Noise Figure Using CAD Tools (3:00 p.m.)

U. Rohde, Compact Software, Upper Saddle River, NJ

CAD software which can assist in the design of low-noise wideband amplifiers with large dynamic range will be described. A unique feature of the software is its ability to perform noise analysis from a nodal description of the circuit. Noise models will be described which obviate the need for measured transistor noise data.

Coffee Break (3:30 p.m.)

TU12 Programmable Microwave Tuner System (PMT) for Device & Circuit Characterization (4:00 p.m.)

K.A. Sivek, Microwave Technology Ctr., RCA Laboratories, Princeton, NJ

A programmable microwave tuner system which can dynamically test microwave circuits under full power conidtions from 0.5 to 26.5 GHz while automatically varying the load impedance over a wide range will be discussed. Optimum circuit efficiency can be determined with respect to noise figure, output power and power-added efficiency. Software has been developed which controls the system and provides algorithms for determining the maximum or minimum values and contour searches.

TU13 Computer-Aided Manufacturing — A User's Point of View (4:30 p.m.)

Charles Buntschuh, Narda Microwave Corp, Hauppauge, NY

A dream of the microwave manufacturing community is the super, computer-aided design-to-production process. It starts with an engineer sitting at a sophisticated design machine complete with accurate and proven circuit models which can handle everything from small parasitics to nonlinear effects. It ends with the measurement process which is also automated. The output is fed back to the initial design machine for correlation and possible design modification. Where are we in the realization of this dream? A general overview and some specific examples will be given.

TU14 MATE — The Air Force Initiative to Standardize Languages Between the ATE Systems (5:00 p.m.)

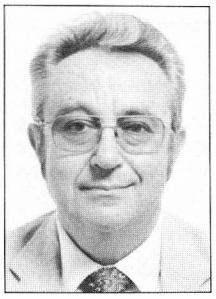
Bryan Walker, Systron Donner Corp., Concord, CA

This paper will introduce the Air Force MATE program, its objectives and its effects on commercial test equipment. A typical MAT test system will be described. The chain of control languages from the high level test programming language to the low level test instrument control language will be presented. Special emphasis will be given to the Control Intermediate Interface Language (CIIL) and its usefulness as a generic instrument control language.

TU15 Symposium Closing (6:00 p.m.)

Exhibits Close (7:00 p.m.)

LECTURERS AVAILABLE FOR SELECTED TOPICS IN MICROWAVE MEASUREMENTS



by Stephen F. Adam,
Chairman: MTT-11

I would like to offer the availability of a number of lecturers, who volunteered their time to give lectures to your local Chapter or Section meetings. Some of them are also available to speak at other institutions or other IEEE Society meetings. Below please find a list of their names and their proposed topics.

If you know of additional speakers in this area willing to volunteer their time to join this group, please let me know.

Dr. Glenn F. Engen
(recently retired from NBS)
333 Sunrise Lane
Boulder, CO 80302

TOPIC: "An Introduction to the Six-Port Automatic Network Analyzer"

Dr. Engen has no supporting organization and requires financial support to cover his travel expenses.

Mr. Cletus A. Hoer
National Bureau of Standards; Code: 723.01
325 Broadway
Boulder, Co 80303

TOPIC: "Six-Port Theory and Applications to Precision Measurement of Microwave, Power, Impedance and Scattering Parameters"

Dr. David F. Wait
National Bureau of Standards; Code: 723.02
325 Broadway
Boulder, Co 80303

TOPIC: "The NBS Coaxial Noise Standard, and Educational Project"

Robert V. Garver
Harry Diamond Laboratories
Attn: SLCHD-NW-RE
2800 Powder Mill Rd.
Adelphi, MD 20783-1197

TOPIC: "Dynamic Measurement of Wide Dynamic Range Responses"

Mr. Frank K. Koide
Koide International Consultants
5757 Caminito Empresa
La Jolla, CA 92037
(619) 546-9084

TOPIC: "Promotion of National Microwave Standards"

Limited funds are only available for travel and mostly to the Southwest. Other places, please consult with Mr. Koide.

Dr. Barry S. Perlman
RCA — David Sarnoff Research Center
P.O. Box 432
Princeton, NJ 08540-0432
(609) 734-2000

TOPICS: "Software Issues in Automatic Test"
"Multipurpose Large Scale ATE"
"Application Specific Custom Instrumentation for Test"
"CAE — Integrating Design and Test"
"Knowledge Based 'Expert' Test Methodology'

Dr. Perlman has only limited funds for travel, but would like to be available if funds for travel can be provided.

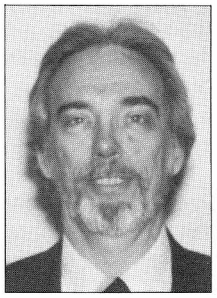
Mr. Eric Strid, President
Cascade Microtech, Inc.
P.O. Box 1589
Beaverton, OR 97075-1589
(503) 626-8245

TOPIC: "Developments in Microwave and Millimeter Wave Chip and Hybrid Level Testing and Database Development"
...or a variation of this theme.

Mr. Lawrence G. Rubin
National Magnet Labs
Massachusetts Institute of Technology
Building NW14-1108B
Cambridge, MA 02139
(617) 253-5517

TOPIC: "Strong dc Magnetic Fields: How to Produce and Measure Them"

MEMBERSHIP DEVELOPMENT



by Alton L. Estes

1986 IN REVIEW

Membership Reaches New Record High

A steady and record increase in MTT-S Membership has continued this year for the 9th straight year. The Institute Membership totaled 282,708 for 1986, up 3.3% over 1985. The Society ranked 5th in IEEE Society growth among 33 societies compared to 6th last year. MTT-S membership increased 8.4% over 1985 membership due to the addition of a record 730 members which brought the total membership to 9445 members at the end of 1986. This growth compares favorably to the Institute Society Membership growth of 3.3%.

Orlando, Philadelphia, Sweden and West Germany Chapters received $200 and a plaque at the 1986 International Microwave Symposium Chapter Chairman's Meeting in recognition of their outstanding efforts in promoting membership in 1985.

Congratulations to the Baltimore, India Council, Schenectady and West Germany Chapters for their outstanding efforts in promoting MTT-S membership in 1986. Each representative from the four Chapters shall receive membership recognition awards, $200 plus a plaque, at the 1987 International Microwave Symposium Chapter Chairmans' dinner.

Rapid Growth of Chapters Continues

The number of MTT-S Chapters increased 18.6% compared to 1985 due to the formation of eight new Chapters in 1986: Beijing; People's Republic of China; Cleveland, Ohio; Dayton, Ohio; Huntsville, Alabama; Kitchener-Waterloo, Canada; Pretoria, South Africa; Rio de Janeiro, Brazil; and Valencia, Venezuela. This brings the total number of chapters to 51. With the addition of these eight chapters, the Chapter Membership increased to 6748 members in 1986, up 12.0% compared to the 6025 members that belong to Chapters at the end of 1985. Two other new Chapters are being organized in England and Denmark.

1986 in Perspective

The MTT-S membership booth at the 1986 International Microwave Symposium was a success. Over 35 members were added to the rolls of the Society, of which about 30 members joined the IEEE, due to the membership promotional efforts of AdCom and the Baltimore Chapter.

Ten Chapters achieved membership growth for each of the past five years. The ten Chapters' membership statistics for the past six years follow.

Chapter	Membership by Year 1981	1982	1983	1984	1985	1986	Five Year Increase (%)
Central Illinois	35	37	41	49	53	63	80.0
Central N.E. Council	427	465	545	589	624	633	48.2
Dallas	141	172	191	200	224	266	88.7
Milwaukee	16	17	20	29	39	54	237.5
Ottawa	49	54	64	84	89	95	93.9
Philadelphia	103	104	123	135	168	169	64.1
Princeton	64	68	72	81	96	107	67.2
San Diego	67	72	83	99	111	116	73.1
Santa Clara Valley/ San Francisco	436	448	498	549	593	700	60.6
Syracuse	47	51	53	55	65	71	51.1

Four more Chapters can join this list next year if they continue to increase membership in 1987: Chicago, Denver, Orlando and Sweden. Paying atention to quantity and quality of Chapter technical meetings and adding a Membership Committee to each Chapter's organization will help retain and increase membership.

Nine years of Society growth has continued as shown in the table listing the total year-end Membership statistics for the previous twenty-one years. These statistics are published here so that Society Membership can better understand the significant achievement that occured over the past nine years. The growth may

continued on page 54

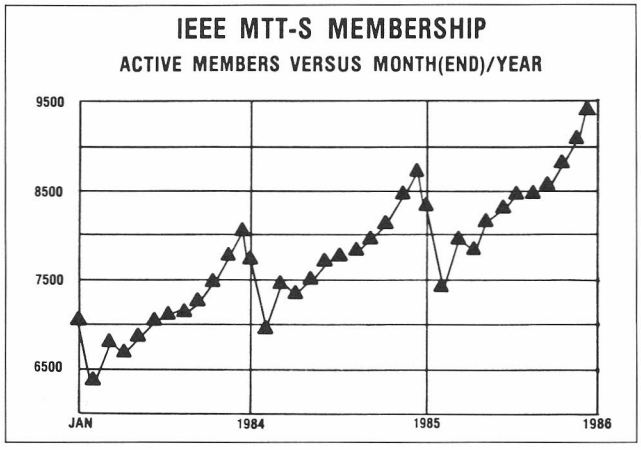
Year End MTT-S Membership Statistics

Year End	Total Members	Change from Last Year	
1965	5533		
1966	5836	+303	+5.48%
1967	6140	+304	+5.21%
1968	6384	+244	+3.97%
1969	6933	+549	+8.60%
1970	6799	−134	−1.93%
1971	6295	−504	−7.41%
1972	5697	−598	−9.50%
1973	5711	+ 14	+ .25%
1974	6162	+451	+7.90%
1975	6261	+ 99	+1.61%
1976	6155	−106	−1.69%
1977	5608	−547	−8.89%
1978	5696	+ 88	+1.57%
1979	5933	+237	+4.16%
1980	6429	+496	+8.36%
1981	6635	+206	+3.20%
1982	6968	+333	+5.02%
1983	7435	+467	+6.70%
1984	8064	+632	+8.46%
1985	8715	+651	+8.07%
1986	9445	+730	+8.38%

Membership Development (continued from page 53)

continue for over ten years if the Chapters work to retain and add members. One of the best methods to retain membership is for the Chapters to encourage maximum involvement of the membership in Society activities. Certainly, one of the best methods to add membership is to...support the Membership Drive!!!

A plot of IEEE MTT-S Membership growth for the past three years and a table of total active members by month for the past four years are shown below. The dips that occur at the end of February and April will be explained in future reports. The plot and table is included for future reference of all members. It appears that the 1986 membership growth statistics is very similar to that of recent years.



Total Active Members

Month	1983	1984	1985	1986	Total	Change from 1985 Percent
January	6711	7085	7751	8370	467	5.9
February	6085	6407	6971	7441	470	6.7
March	6468	6847	7465	7963	498	6.6
April	6336	6698	7356	7948	592	8.0
May	6465	6899	7512	8211	699	9.3
June	6577	7076	7728	8346	621	8.0
July	6649	7134	7770	8443	673	8.6
August	6707	7152	7827	8454	627	8.0
September	6811	7297	7943	8530	587	7.4
October	6972	7500	8150	8825	680	8.3
November	7145	7786	8475	9097	622	7.3
December	7435	8064	8715	9445	730	8.4

Acknowledgement

The recent year's MTT-S Membership growth was largely due to Pat Green's leadership as the Membership Development Officer and to the other Society members he influenced to recruit many new members. Pat Green assumed a special engineering assignment in late 1986 that required his full occupation. Consequently, he resigned as Membership Development person in the Fall of 1986.

1987 MEMBERSHIP DEVELOPMENT

Objectives

The major 1987 goals of Membership Development are:

1) To undertake a maximum **new** Society membership recruitment effort.
2) To continue to **increase** the numbers of members belonging to the Society.
3) To maintain **existing** Society Membership by taking appropriate actions to retain Members.
4) To promote **elevation** in IEEE grade so that all Members hold the highest grade for which they are qualified.

Actually, if goals 1 and 3 are realized then the 2nd goal will probably occur. Achieving the 4th goal will require more coordination between Chapters and the IEEE Sections that encompass the MTT-S Chapters than for the first three goals.

A new membership drive is underway and will be discussed in another article of this newsletter. Methods to maximize new membership are being evaluated for proposal to AdCom since some methods require funds that are not budgeted for 1987.

An investigation into the past few years of membership statistics is planned and will be reported to AdCom in the June meeting. These statistics will be used to determine the success of prior years' membership drives to recruit members who continue with the Society. Questions such as "How much of the growth was due to members who have never joined the Society?" or "How many members rejoined after dropping out for a year?" will be answered quantitatively.

The Institute is promoting elevation in grade and in particular the elevation to Senior member by those who qualify. A member should always seek to hold the highest member grade he or she is qualified for in his or her professional Society. If you have been working in the profession for ten years or more and have demonstrated significant performance for at least five of those years, you may be qualified to be elected to the grade of Senior Member. Check with your Chapter or Section officers for further information and applications to elevate your grade.

January Progress Report

The MTT-S membership increased 7.9% to 9,033 as compared to 8,370 members at the end of January 1986. The number of members whose dues are in arrears is 1,359 compared to 789 at the end of January 1985. The arrears increase over last year was anticipated and letters and questionnaires have been mailed to those members in arrears in an attempt to identify why these members have elected to drop MTT-S. The results of the questionnaire will be used to determine actions to maintain the value and effectiveness of the MTT-S to meet the needs of the individual members and therefore the Society as a whole.

There will be a Membership booth at the 1987 International Microwave Symposium. Please drop by and visit with the Membership Development person, Al Estes, and the AdCom members who will be contributing their time to increase membership at the booth. The booth is located in the Registration area.

MTT SOCIETY EXHIBITS ARTIFACT COLLECTION

Reprinted with permission from IEEE Center for the History of Electrical Engineering Newsletter)

Since 1980, the IEEE Microwave Theory and Techniques (MTT) Society has mounted a comprehensive historical exhibition at the annual International Microwave Symposium. The core of the exhibit is a collection of nearly 100 microwave devices assembled by Theodore Saad, President of Sage Laboratories and Historian of the MTT Society. However, Saad also makes arrangements with local microwave companies near the convention city to participate in the exhibit.

The latest of these exhibitions was held at the 1986 MTT-S International Microwave Symposium held in Baltimore. The MTT artifacts ranged from a late 1920's power pentode, to klystrons and magnetrons from the 1940's, to a GaAs dual-gate FET, c. 1980. The devices, donated to the MTT by its members and other interested parties, are international in origin, with items from the United States, Germany, Japan and the People's Republic of China. Complementing this display were several large pieces of radar equipment and a series of display panels from the nearby Baltimore Electronics Museum.

Photo credit: IEEE Center for the History of Electrical Engineering

MTT-S International Microwave Symposium Baltimore, 1986. Displays, like the ones shown here, from the Baltimore Electronics Museum, complemented the MTT-S Historical Exhibit.

The MTT artifact collection traces its origins to 1980, when Saad first borrowed items from the MTT Museum and microwave companies to display at that year's Symposium. The MTT then began receiving artifacts for its permanent collection, gathering 19 devices that first year. The collection now contains 91 artifacts, 60 books on the history of microwave science and technology, and 15 miscellaneous items, including patent records and photographs. A copy of the unpublished catalogue of the collection, containing detailed descriptions of each piece, is available for research use at the Center of the History of Electrical Engineering.

Photo credit: IEEE Center for the History of Electrical Engineering

MTT Historical Exhibit at MTT-S International Microwave Symposium, Baltimore, 1986. Dr. Ronald Kline (left), Dire., Ctr. for the Hist. of E.E., and Prof. John Bryant view MTT-S artifacts.

The care of the collection, which has been Mr. Saad's responsibility, will be transferred to Dr. John Bryant, University of Michigan, at the conclusion of next year's Symposium in Las Vegas. Dr. Bryant is one of the two Distinguished Microwave Lecturers appointed by the MTT Society for 1986-1987. His lecture on "The First Century of Microwaves — 1886-1986" is available for bookings by IEEE Chapters and Societies between July 1986 and June 1987. In his talk, Dr. Bryant will describe Hertz's historic experiments of 1886-1888, which verified Maxwell's electromagnetic theory. He will also talk about the advancement of microwave techniques and technology after Hertz, and will conclude with a discussion of the development of systems applications in microwave technology. Because of his keen interest in the history of microwaves, Dr. Bryant was selected to take over the responsibility for the MTT artifact collection.

For more information on the MTT artifact collection, contact Theodore Saad, Sage Laboratories, 3 Huron Drive, Natick, MA 01760, (617) 653-0844. Arrangements for Dr. Bryant's lecture should be made directly with him, c/o Dept. of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI 48109, (313) 633-3618.

MEMBERSHIP DRIVE

by Alton L. Estes, Membership Development

Free Membership for New MTT-S Members

New members joining MTT-S will receive free MTT-S membership to the end of 1987. These new members may be IEEE members that do not currently belong to the MTT-S **or** they can join the IEEE and the MTT-S concurrently. This free membership offer should stimulate your colleagues and friends to join MTT and benefit from the educational opportunities that the Society has to offer.

Why Add Members?

The purpose for adding members is to expand a skilled and enthusiastic Membership so as to enhance the value, the technical scope, and the effectiveness of the Society. One of the most important objectives of MTT-S is to serve the professional interests and needs of those engaged in the use of microwave theory or are using techniques that employ microwave field theory. MTT-S has the major task of reaching the large number of potential members engaged in the use of microwave theory or are using techniques that employ microwave theory.

A new MTT Society membership brings with it publications and an awareness of technical conferences, tutorials and workshops targeted toward the new members' primary technical interests. Adding a 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.

Need Membership Applications?

Membership applications were mailed in mid-March by Bill Hunter to all Chapter Chairmen. These applications reflect the reduction in IEEE membership fees and the free MTT-S membership. Please use these applications since they have a tracking code that will allow the IEEE to give the Society a five dollar rebate for each new IEEE member added. You may photocopy these applications.

Warning!

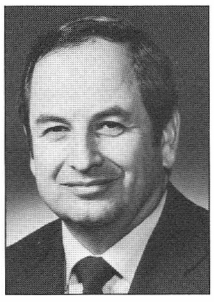
These applications are valid until August 31, 1987 since the applications show the half price fee. When sending in applications that will be received after August 31, 1987, please use the applications that will be mailed to the Chapter Chairmen in mid-July. These applications will show the full price fee for joining IEEE after August 31, 1987. Now is the time to get new members since the fee to join IEEE is reduced to half price.

Who to Contact

For assistance in adding members, use your 1987 MTT-S Committee Directory to find the address and phone number of your Chapter Chairman, the AdCom Liaison assigned to your Chapter, or the Membership Development Officer, Al Estes. Contact Bill Hunter (address below) for membership development supplies, brochures, Information Centers, and suggestions that will be a valuable aid in promoting membership.

Mr. William Hunter, Coordinator
IEEE Membership Development
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
U.S.A.
(201) 981-0060, X301

CHAPTER OFFICERS' RECORDS



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

A request to Chapter Officers:

Please send me **copies** of your Chapter's Meeting Reports (yellow Form L-31 that you send to your Section after every meeting). These copies are needed for publication of the records of your Chapter's meetings in the MTT-S Newsletter.

My address and telephone number are listed above.

HOW TO WIN AT TELEPHONE "TAG"

Telephone tag, the seemingly endless cycle of calls and returned calls that are missed, is one of the more time-consuming frustrations of executive life. Beat the frustration by organizing your telephone tactics.

If the person you want to talk with isn't in, and you do want him to call you back:

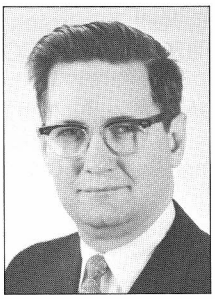
- *Leave a detailed message of the subject of the call.*
- *Note a time span when you'll definitely be available.*
- *Make a phone appointment — a specific time when the part can reach you.*
- *Tell the secretary that no reply will be an assumed consent or agreement.*

If you don't want the other party to call back:

- *Ask for a specific time when he/she will be available, so you can try again.*
- *Find out if the person can be paged.*
- *Request that the secretary relay the information to your secretary, keeping the bosses out of the phone process.*

Execu-Time, Box 631, Lake Forest, IL 60045, 24 issues, $65/yr.

PACE REPORT



by R.A. Moore

SYMPOSIUM NOTE

Make your plans now to attend the International Microwave Symposium luncheon panel: **Financial Planning for Engineers — Implications of the New Tax Law**. To be held June 9, 12:00-1:30 (first day of the Symposium).

LEGISLATIVE UPDATE

Individual Retirement Accounts: The new "Tax Reform Act" has removed the tax deferral provision of IRA deposits for most engineers working for companies with pension plans. The USAB position is that this deprives most such engineers of an effective pension approach consistent with employment mobility. The USAB continues to lobby to get this provision amended and recommends that every engineer write their representative and senators.

Status of Consultants: As discussed earlier in this article, section 1706 of the new Tax Reform Act requires, in effect, that engineers, scientists and computer professionals qualify differently than many professionals to qualify as independent consultants rather than employees. The proposed USAB entity position statement reads in part as follows:

"The Institute of Electrical and Electronics Engineers, Inc. opposes any legislation which singles out engineers, scientists and computer professionals for unfair or discriminatory treatment."

"Section 1706 of the Tax Reform Act adversely affects a specific segment of the nation's scientific, technical and engineering work force by depriving them of rights to which they have been entitled under prior law and which continue to apply to taxpayers in other professions and occupations. More specifically...."

"The legislative history of Section 1706 suggests that it is the result of efforts by the members of one group of technical services firms to gain an economic advantage over another by manipulating Federal tax policy. The short term result of this legislation has been to create confusion and uncertainty about the employment status and attendant tax liability of thousands of engineers and computer specialists, many of whom are independent businessmen. The dislocation that Section 1706 will create will have a chilling effect on innovation and productivity throughout the nation's research and development community."

"Section 1706 must be immediately repealed or amended so that it will apply fairly and equitably to all occupations."

"The IEEE encourages all members to inform themselves about this new law and to communicate about it with their Senators and Representatives."

For the complete position and a more lengthy discussion the reader is referred to **The Institute**, March 1987, page 7.

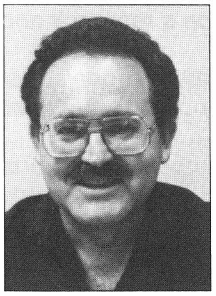
Strategic Electronic Materials: The USAB Defense R&D Committee has undertaken active participation in a "Strategic Electronic Materials Initiative." The program would establish four Centers of Excellence in Electronic Materials, which would be funded by the U.S. Department of Defense. A task force of the Defense R&D Committee has met with many government officials.

Although the Committee has been successful in securing endorsements for the proposal, budgetary constraints have made a commitment for funding more difficult. The Committee will continue to promote the proposal before various government bodies in 1987.

USAB Position on Engineering Research and Development: The USAB approved a Position Statement at its November 1986 meeting which contains several recommendations on industrial competitiveness and implementation problems, including:

- A national R&D policy should be declared, preferably by the Executive Office of the President;
- A concerted effort by government, industry and on uninversities to orient their R&D enterprises to conform with this policy should be formulated, coordinated and immediately launched.
- The Federal Government should recognize there is a point beyond which industry cannot support the R&D enterprise and the government must provide the necessary additional support; and
- Government and industry must increase their support for maintaining strong engineering facilities, modern laboratory equipment for research and education and basic engineering research outside the Engineering Research Centers on university campuses.

ARFTG HIGHLIGHTS



by Mario A. Maury, Jr.

The Automatic RF Techniques Group (ARFTG) is a professional society that is affiliated with MTT-S. It is primarily concerned with computer-aided microwave measurements and design. The following is a summary of its recent activities.

28th ARFTG CONFERENCE

The Winter 1986 ARFTG Conference was held at the Don CeSar Beach Resort, St. Petersburg Beach, Florida on December 4 and 5, 1986. The Conference's main topic was "Precision Microwave Measurements" and the Conference Chairman was John Barr, Hewlett Packard Company, Santa Rosa, California. The local host was Bob Ashley of Tampa, Florida.

Ray Tucker of Rome Air Development Command, Griffiss AFB, New York and President of ARFTG opened the meeting and welcomed the attendees to the sunny gulf coast of Florida.

The Technical Program Chairman was Dave Hopping, Hewlett Packard Company, Santa Rosa, California, who put together an excellent program consisting of 14 technical papers. The following is a listing of the papers presented.

"Improved Calibration for Network Analyzers"
William Oldfield, Wiltron Co.

"Mechanical Characterization of Calibration Standards for Improved Accuracy"
Gary R. Simpson, Maury Microwave Corporation

"A RF Network Analyzer Verification Process Using a Short Length of Precision Transmission Line"
Geraldine A. Conrad,
Hewlett Packard Company — NMD

"Measurement Environment Simulation of a Microwave Automatic Network Analyzer"
Vahid Sotoudeh, EIP Microwave, Inc.

"Automatic MW Attenuation Calibration System Linearity Certification Technique"
J.W. Cable, Bendix Corporation

"ANA Measurement Results on the ARFTG Traveling Experiment"
Leon Saulsbery & Robert Adair, NBS, Boulder, CO

"A Transient Response Error in Microwave Power Meters Using Thermistor Detectors"
Fred R. Clague & Neil T. Larsen,
NBS, Boulder, CO

"A HP8409B Based Power Sensor Calibration System"
J.G. Burns,
Applied Physics Lab of Johns Hopkins Univ.

"Determining Fixture Scattering Parameters from Two Sets of HP8510 Error Vectors"
Richard Lane, California Eastern Labs

"The 2.4mm Coaxial Connector — Its Design and Development Using the HP8510"
Karl Kachigan, Hewlett Packard Company — NMD

"An Automated Frequency Domain Scalar Network Analyzer Technique for the Separation of Small Reflections"
Roger Billings & David McIntosh,
M/A-COM Omni Spectra, Inc.

"A PC-Based Microwave Measurement Environment"
Mark Roos, EIP Microwave, Inc.

"Automated Interfacing in Computer Programming"
H.E. Stinehelfer Sr., Raytheon Bedford Labs

"New Computer-Aided Test Program Greatly Enhances Network Analyzer Calibration and Characterization"
Glenn Ingel & Larry Lerner, EEsof, Inc.

A panel session entitled, "Precision and Metrology of Everyday Measurements," was held on Thursday afternoon. It was moderated by Dave Hopping, the TPC for the Conference and consisted of the following panel members:

— Robert T. Adair, National Bureau of Standards, Boulder, Colorado

— Richard Q. Lane, California Eastern Labs, Santa Clara, California

— Mario A. Maury, Jr., Maury Microwave Corp., Cucamonga, California

— William Oldfield, Wiltron Co., Mountain View, California

— Frank Mendoza, TRW, Redondo Beach, California

Each panel member was given a chance to present his views and comments relating to everyday measurement. A spirited discussion then followed which highlighted the following areas as requiring improvement:

— Lack of good test cables and a need to understand their proper use.

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ARFTG Highlights (continued from page 57)

— Better training/education; in measurement methodology and use of sophisticated computer controlled equipment
— Formal education provided by universities in metrology
— Care and proper use of calibration standards and test ports
— Communications between different phases of the measurements process; design, testing and quality assurance
— Better understanding and use of statistical quality control.

Vendor Exhibits were also held at the Conference and 11 Exhibitors participated as listed below:

Adams Russell
Eaton
EEsof
EIP Microwave
Hewlett Packard Co.
Hughes Aircraft Co.
Maury Microwave Corp.
Made-It-Associates
RCA/Princeton
Waveteck Microwave
Wiltron

A continental breakfast and all the breaks were held in the exhibits area on both days of the Conference.

The semi-annual ARFTG Awards Banquet was held the evening of December 4 and the following awards were presented by Ray Tucker, ARFTG President:

Conference Chairperson, 28th Conference
John Barr IV, Hewlett Packard Co., Santa Rosa, CA

Technical Program Chairman, 28th Conference
Dave Hopping, Hewlett Packard Co., Santa Rosa, CA

Conference Host, 28th Conference
J. Robert Ashley, Tampa, FL

Best Paper Award, 27th Conference
James Rautio, Syracuse University, Syracuse, NY

ARFTG Distinguished Service Award
Lee Saulsbery, NBS, Boulder, CO

Automated Measurements Technology Award
J. Robert Ashley, Tampa, FL

Automated Measurements Career Award
Rudolf E. Henning, University of S. Florida, Tampa, FL

A very interesting and thought-provoking IEEE slide show was presented at the Banquet entitled, "Education: The Key to America's Future."

Entertainment was provided by a local music department (ably assisted by J. Robert Ashley). The Gilbert and Sullivan takeoff was entitled: "ARFTG Unlimited" or: (The Mess that Caused a Failure).

29th ARFTG Conference

The Summer ARFTG Conference will be held as a workshop as part of the 1987 MTT-S International Microwave Symposium. The Conference will be held on June 12 and 13 (a.m. only), 1987, at Bally's Grand Hotel in Las Vegas, Nevada. Advance registration is recommended utilizing the Symposium registration form, although attendees can register at the Conference.

The theme of the Conference will be "Noise Parameter Characterization." Technical presentations will be informal 25 minute talks using viewgraphs or 35mm slide illustrations. Manufacturers are also encouraged to discuss or demonstrate new products that have been developed for RF design and testing: a separate exhibits area will be available for demonstrations. All accepted papers will be published in the Conference Digest. Please refer to the "ARFTG Instructions to Authors" for additional information.

Technical Program Chairman (TPC):
Maurice Moberg
Avantek, M/S M38
481 Cottonwood Drive
Milpitas, CA 95035-7492
(408) 943-7633

Manufacturers interested in exhibiting their products, contact the Exhibits Chairman (EC):
Gary Simpson
Maury Microwave Corporation
8610 Helms Avenue
Cucamonga, CA 91730
(714) 987-4715, X41

For further information, contact the ARFTG Conference Chairman (CC):
Peter Lacy
Wiltron Company
825 E. Middlefield Road
Mountain View, CA 94043
(415) 969-6500, X3201 or 4366

This ARFTG Conference promises to be an outstanding success with an excellent Technical Program, Awards Banquet and Exhibits — in an outstanding convention location — plan to attend this one!

Sign Off — Sign On

This will be my last "ARFTG HIGHLIGHTS" article since I have retired from ARFTG EXECOM in order to devote more time to my MTT-S responsibilities. I have really enjoyed reporting on ARFTG activities for the past four years and I would like to thank my predecessor and good friend, George Oltman (TECOM, Chatsworth, California) for having started this column.

Don't despair, I leave you in good hands; Ray Tucker is now the MTT-S coordinator for ARFTG and will be responsible for this article in the future (he also is the current ARFTG EXECOM President). I have listed Ray's address and phone number below in case you would like to contact him concerning ARFTG:

Mr. Raymond W. Tucker
Rome Air Development Center
EMC Branch, RADC/RBCA
Griffiss AFB, NY 13441
(315) 330-2841

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ARFTG Highlights (continued from page 59)

Join ARFTG

Although I have retired from writing this column and ARFTG EXECOM, I will continue to be an active member of ARFTG and I am extremely proud to be part of this outstanding group — it will always have my strongest support.

If you are involved in computer-aided microwave testing and design (CAT & CAD) — and aren't most of us? I strongly urge you to join ARFTG. It is an extremely rewarding experience to attend an ARFTG Conference, to mingle with your peers and at the same time keep current with our ever-evolving technology.

MEETINGS OF INTEREST

GENERAL INTEREST

1987 University/Government/Industry Conference — June 9-11. Hilton Inn on the Campus, Rochester Institute of Tech., Rochester, NY. Contact: Dr. Lynn Fuller, Rochester Inst. of Tech., Rochester, NY 14692, (716) 475-2035.

1987 IEEE Annual Meeting — June 18-19. New York Marriott Marquis, New York, NY. Contact: Adeline T. Zeni, Annual Meetings Admin., 345 East 47th Street, New York, NY 10017, (212) 705-7304.

MIDCON '87 — Sept. 15-17. O'Hare Exposition Center, Rosemont, IL. Contact: Ms. Alexes Razevich, Electronic Conventions Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965, (800) 421-6816.

NORTHCON '87 — Sept. 22-24. Portland Memorial Coliseum, Portland, OR. Contact: Ms. Alexes Razevich, Electronic Conventions Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965, (800) 421-6816.

Electrical and Electronics Conference and Exposition — Sept. 28-30. Metro Toronto Convention Centre, Toronto, Ontario, Canada. Contact: IEEE Canadian Region Office, 7061 Yonge St., Thornhill, Ont. L3T 2A6, Canada, (416) 881-1930.

International Professional Communication Conference — IPCC '87 — Oct. 14-16. Sheraton Hotel Winnipeg, Winnipeg, Manitoba, Canada. Contact: Ron S. Blicq, General Chairman, The Roning Group, Box 181, Postal Station C, Winnipeg MB Canada R3M 3S7, (204) 632-2292.

Western Electric Show & Convention (WESCON '87) — Nov. 17-19. Moscone Center and Brooks Hall, San Francisco, CA. Contact: Ms. Alexes Razevich, Electronic Conventions Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965, (800) 421-6816.

AEROSPACE/MILITARY

Naecon '87 Technical Program and Exhibition — May 18-22. Dayton Convention Center, Dayton, Ohio. Contact: Mary Terbay, National Aerospace & Electronics Conference, 110 E. Monument Ave., Dayton, Ohio 45402, (513) 254-5377.

IEEE Military Communications Conference (MILCOM 87) — Oct. 19-22. McLean Hilton, McLean, VA. Contact: Mr. Alan J. Roberts, The Mitre Corporation, M/S W300, 1820 Dolley Madison Blvd., McLean, VA 22102-3481, (703) 883-5691.

CIRCUIT THEORY

1987 IEEE International Symposium on Circuits and Systems — ISCAS '87 — May 4-7. Dunfey City Line Hotel, Philadelphia, PA. Contact: Samuel D. Bedrosian, General Chairman, Department of Electrical Engineering, University of Pennsylvania, Philadelphia, PA 19104, (215) 898-8518 or Professor W.K. Chen, University of Illinois, Box 4348, Chicago, IL 60680, (312) 996-2462.

COMMUNICATIONS

GLOBECOM '87 — Nov. 15-18. Keio Plaza Intercontinental Hotel, Tokyo, Japan. Contact: Noriyoshi Kuroyanagi/NTT ECL, Musashino, Tokyo 180, Phone: +81-422-59-2539, Telex: 02822620 NTT ECLJ or Takuro Muratani, General Affairs Chairman, R&D Labs., KDD, Nakameguro, Tokyo 153, Phone: +81-3-713-0111, Telex: J 22500 KDD TOK In N.Y. (212) 705-7857.

COMPUTERS

1987 First IEEE International Conference on Computer Vision — June 8-11. London, England. Contact: Dr. Azriel Rosenfeld, Center for Automation Research, University of Maryland, College Park, MD 20742, (301) 454-4526.

1987 Conference on Software Maintenance — Sept. 21-23. Washington, DC. Contact: Software Maintenance, 1730 Massachusetts Ave., NW, Washington, DC 20036-1903, (202) 371-0101. TWX: 7108250437 IEEECOMPSO.

IEEE Computer Society International Conference on Computer Languages — Oct. 27-30. Konover Hotel, Miami Beach, FL. Contact: IEEE Computer Society, 1730 Massachusetts Avenue, NW, Washington, DC 20036-1903, (202) 371-0101, TWX: 7108250437 IEEECOMPSO.

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Meetings of Interest (continued from page 60)

IEEE International Conference on Computer Aided Design (ICCAD '87) — Nov. 9-12. Santa Clara Convention Center, Santa Clara, CA. Contact: Dr. Basant Chawla, AT&T Bell Laboratories, 1247 S. Cedar Crest Blvd., Allentown, PA 18103, (216) 770-3485.

INSTRUMENTATION

IMTC '87 — Instrumentation & Measurement Technology Conference — April 27-29. Sheraton-Boston Hotel, Boston, MA. Contact: Robert Myers, 1700 Westwood Blvd., #101, Los Angeles, CA 90024, (213) 475-4571.

MICROWAVES

1987 IEEE Microwave and Millimeter Wave Monolithic Circuits Symposium — June 8-9. MGM Grand Hotel, Las Vegas, NV. Contact: Dr. Yalcin Ayalsi, Hittite Microwave Corp., 5 Ingleside Road, Lexington, MA 02173, (617) 933-7267.

1987 IEEE MTT-S International Microwave Symposium — June 9-11. MGM Grand Hotel, Las Vegas, NV. Contact: Steven L. March, Conference Chairman, Maury Microwave Corp., 8610 Helms Avenue, Cucamonga, CA 91730, (714) 987-4715.

1987 IEEE/AP-S International Symposium and URSI/USNC Radio Science Meeting — June 15-19. Virginia Tech Continuing Education Center, Blacksburg, VA. Contact: Dr. Warren Stutzman, Virginia Tech, Electrical Engineering Dept., Blacksburg, VA 24061, (703) 961-6835.

1987 2nd International Microwave Symposium/ Brazil — July 27-30. Rio Palace Hotel, Rio de Janeiro, Brazil. Contact: Prof. Alvaro Augusta A. de Salles, 1987 INTERNATIONAL MICROWAVE SYMPOSIUM/ BRAZIL COMMITTEE, CETUC-PUC/RJ, Rua Marques de Sao Vicente, 225-Gavea, CEP: 22451, Rio de Janeiro-RJ-BRAZIL. Telex: 2131048.

12th Annual IEEE International Conference on Infrared and Millimeter Waves — Dec. 14-18. Americana Dutch Resort Hotel, Orlando, FL. Contact: Kenneth J. Button, Conf. Chairman (Temporary), Box 72, M.I.T. Branch, Cambridge, MA 02139-0901, (617) 253-5561, (617) 489-4353, Telex: 92-1473.

QUANTUM ELECTRONICS

Conference on Lasers and Electro-Optics (CLEO '87) — April 27-May 1. Baltimore Convention Center, Baltimore, MD. Contact: OSA, Meetings Department, 1816 Jefferson Place, NW, Washington, DC 20036, (202) 223-0926.

1987 Quantum Electronics Conference — April 27-May 1. Baltimore Convention Center, Baltimore, MD. Contact: OSA, Meetings Department, 1816 Jefferson Place, NW, Washington, DC 20036, (202) 223-0926.

RELIABILITY

3rd Annual Conference on Electronic Packaging and Corrosion in Microelectronics — April 26-30. The Radisson South, Minneapolis, MN. Contact: Professor Morris E. Nicholson, 1776 North Pascal Avenue, St. Paul, MN 55113, (612) 645-1613.

SOLID STATE

19th IEEE Photovoltaic Specialists Conference — May 4-8. Sheraton New Orleans Hotel, New Orleans, LA. Contact: Dr. Lawrence L. Kazmerski, Conference Chairman, Solar Energy Research Inst., 1617 Cole Blvd., Golden, CO 80401, (303) 231-1115.

1987 University and Government and Industry Conference — June 9-11. Hilton Inn on the Campus, Rochester Institute of Technology, Rochester, NY. Contact: Lynn Fuller, Rochester Institute of Technology, Rochester, NY 14692, (716) 475-2035.

1987 Device Research Conference — June 22-24. Santa Barbara, CA. Contact: Michael S. Adler, Electron Devices Society, General Electric Company, P.O. Box 8 — Room KW-C328, Schenectady, NY 12301, (518) 387-5882 or Dr. Jerry Woodall, IBM Watson Research, P.O. Box 218, Yorktown Heights, NY 10598, (914) 945-1568.

11th Biennial IEEE/Cornell University Conference on Advanced Concepts in High Speed Semiconductor Devices and Circuits — August 10-12. Cornell University, Ithaca, NY. Contact: C.O. Bozler, MIT Lincoln Laboratory, P.O. Box 73, Lexington, MA 02173.

1987 IEEE International Electron Devices Meeting (IEDM '87) — Dec. 6-9. Washington Hilton, Washington, DC. Contact: Ms. Melissa Widekehr, c/o Courtesy Associates, Inc., 655 15th Street, NW, Suite 3000, Washington, DC 20005, (202) 347-5900.

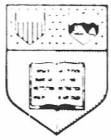
MISCELLANEOUS

37th Electronic Components Conference (ECC) — May 11-12. Boston Park Plaza, Boston, MA. Contact: Mr. James A. Woolley, 3M Company, 3M Center, 207-1W-10, St. Paul, MN 55144, (612) 733-9699.

41st Annual Frequency Control Symposium — May 27-29. Dunfey City Line Hotel, Philadelphia, PA. Contact: R.L. Filler, U.S. Army Electronics Technology and Devices Lab., Attn: SLCET-EQ, Fort Monmouth, NJ 07703-5000, (201) 544-2467.

ANNOUNCEMENT AND CALL FOR PAPERS

For the Eleventh Biennial
IEEE/Cornell University Conference on



ADVANCED CONCEPTS IN HIGH SPEED SEMICONDUCTOR DEVICES AND CIRCUITS

SPONSORED BY: The ELECTRON DEVICES SOCIETY OF IEEE

In Cooperation With: The Microwave Theory and Techniques Society of IEEE

August 10, 11, 12, 1987 (Mon., Tues., Wed.)

Papers are solicited covering the physics and performance of high speed microwave, millimeter-wave, optoelectronic, and digital devices and circuits. Papers which emphasize innovative device concepts and physical phenomena leading to new devices are particularly encouraged. There will be invited papers in key areas. The proceedings of the conference will be published. Suitable subject areas include, but are not limited to:

- Novel materials technologies for devices
- Nanometer fabrication techniques
- Measurement techniques for high speed devices
- High speed optoelectronic devices and circuits
- Two terminal devices
- Heterostructure transistors
- Ballistic and hot electron transistors
- Quantum-coupled and tunnel devices
- Device physics
- Speculative transistor concepts

INFORMATION

The eleventh conference will be held August 10, 11, 12 on the Cornell campus in Ithaca, New York. Both individual and family accommodations will be available in area motels. Dormitory rooms are also available. Write to Ms. Elma Weaver, 424 Phillips Hall, Cornell University, Ithaca, New York 14853, (607) 255-3409, for help in local arrangements.

In order to encourage student presentation of papers, limited financial assistance for travel is available to student first-named authors who are presenting papers. This assistance should be requested when the abstract is submitted.

Prospective authors are invited to submit a 300-word abstract, before *April 1, 1987* to the program chairman:

C. O. Bozler
1987 IEEE / Cornell Conference
MIT Lincoln Laboratory
P.O. Box 73
Lexington, MA 02173

Please note that all neccessary government approvals must be obtained *before* submission of an abstract reporting work that has any government sponsorship.

PROCEEDINGS WILL BE PUBLISHED

1 9 8 7

IEEE AP-S INTERNATIONAL SYMPOSIUM
AND
URSI RADIO SCIENCE MEETING

VIRGINIA TECH BLACKSBURG, VIRGINIA JUNE 15-19,1987

The 1987 International Symposium and Radio Science Meeting, sponsored jointly by the IEEE Antennas and Propagation Society and by United States National Commissions (USNC) A and B of the International Union of Radio Science (URSI), will be held on the campus of the *Virginia Polytechnic Institute and State University, Blacksburg, Virginia from 15 through 19 June, 1987.* This is the premier meeting for experimental, theoretical, and all aspects of applied radiation and propagation of electromagnetic energy. Some 68 technical sessions of IEEE AP-S and URSI have been highly coordinated to provide a comprehensive and well-balanced program. These technical sessions will be augmented by a number of exhibits of hardware and materials related to the antenna and propagation fields of interest. A number of outstanding social events have been arranged for the enjoyment of all attendees with particular emphasis on the cultural heritage of the southwestern Virginia area. The last day of the meeting will be devoted to two short courses and two workshops on timely topics of interest to the antenna and propagation community.

In view of the limited housing available for this meeting, potential attendees are urged to mail their registration in as soon as possible. Copies of the advanced program containing all the necessary information on registration may be obtained from;

Dr. Warren L. Stutzman, General Chairman
Department of Electrical Engineering
Virginia Polytechnic Institute & State University
Blacksburg, Virginia 24061
telephone (703) 961-6835

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