1987
Microwave Career Award
Robert W. Beatty

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

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

The Administrative Committee of the Microwave Theory and Techniques Society has selected Robert Beatty as the recipient of the 1987 Microwave Career Award, "for a career of meritorious achievement and outstanding technical contribution in the field of microwave theory and techniques."

Robert W. Beatty (S'43 - A'45 - M'50 - SM'53 - F'67) was born in York, PA, on May 31, 1917. He received the B.S. degree in electrical engineering from George Washington University, Washington, D.C., in 1939, the S.M. degree in electrical communication from the Massachusetts Institute of Technology, Cambridge, in 1943, and the Doctor of Engineering degree from the University of Tokyo, Tokyo, Japan, in 1972.

From 1940 to 1942 he was employed by the U.S. Naval Research Laboratory, Washington D.C., in work on underwater sound- and radio-direction finding. He was a Staff Aide at the M.I.T. Radar School in 1943 and served in the U.S. Naval Reserve from 1943 to 1946. He has had several years' experience in the field of consulting radio engineering for the radio broadcast industry. From 1948 to 1974 he was employed by the U.S. National Bureau of Standards, working in the field of microwave standards, and was Chief of the Microwave Circuit Standards Section at NBS, Boulder, Colo., from 1955 to 1962. Dr. Beatty received the Department of Commerce Silver Medal in 1963.

Over a period of more than 25 years, he published numerous technical articles, a book on Microwave Network Analysis with Dr. D.M. Kerns (Pergamon Press, 1967), and two National Bureau of Standards Monographs (nos. 137 and 151) concerned with microwave and automated measurements.

He has been a member of Sigma Tau, Theta Tau, Sigma Xi, the Instrument Society of America (ISA) and the International Scientific Radio Union (URSI). He was chairman of U.S. Commission I of URSI from 1957 to 1960 and was editor of the **IEEE Transactions on Microwave Theory and Techniques** during 1963-1965. He was Scientific Editor of Commission I for the 14th and 15th General Assemblies of URSI, and was for many years a member of the Administrative Committee of the IEEE Group on Microwave Theory and Techniques, now the Microwave Theory and Techniques Society.

He was sent by the U.S. National Bureau of Standards to Japan in 1970 to be a guest worker at the Electrotechnical Laboratory (ETL) in Tanashi, Tokyo. While there, he delivered lectures (on microwave standards developed at NBS in Boulder, Colorado) at each of the Imperial Universities in Japan. He received an award from the Director of ETL for meritorious service.

Together with Mr. I. Tajima, President of the Anritsu Electric Company, Tokyo, Japan, he organized the 1973 Microwave Measurement Seminar in Tokyo, Japan, and helped open the first Microwave Exhibition at the U.S. Trade Center in Tokyo.

Since retiring from the National Bureau of Standards in 1974, he has done consulting work for the Jet Propulsion Laboratory, Pasadena, California, and the General Dynamics Electrodynamics Division, San Diego, California.

He was the 1975 MTT-S National Lecturer, delivering a lecture entitled "The Development of Modern Automatic Systems for the Measurement of Network Parameters."

In 1985, he became a part-time employee of the Barth Electronics Co., Boulder City, Nevada.

1987 MTT-S Microwave Prize

Christen Rauscher

The Microwave Prize is awarded to the author of that paper, published in the **IEEE Transactions on Microwave Theory and Techniques, Proceedings of the IEEE,** or other official IEEE publication, which is judged to be the most significant contribution in the field of interest of the Society. The paper must have been published during the period January 1 to December 31 of the year preceding the annual meeting of the Administrative Committee at which the award is considered. The award shall consist of a suitable certificate, a cash sum of one thousand dollars, and a feature publication in the **IEEE Transactions on Microwave Theory and Techniques.** If the paper as published has more than one author, a certificate will be presented to each author and the cash sum of $500 will be provided to each up to a total of $3,000. If more than six authors are involved, the $3,000 will be split equally among the authors.

The 1987 recipient of the Microwave Prize is Christen Rauscher, whose winning paper "Microwave Active Filters Based on Transversal and Recursive Principles" appeared in the December 1985 issue of the **IEEE Transactions on Microwave Theory and Techniques.**

Christen Rauscher (S'73 - M'75 - SM'81) was born in Boston, MA, on November 4, 1944. He received the diploma in electrical engineering and the doctorate degree in 1969 and 1975, respectively, both from the Swiss Federal Institute of Technology, Zurich, Switzerland.

From 1969 to 1976 he worked as an Assistant and Research Associate at the Microwave Laboratory of the Swiss Federal Institute of Technology, where he conducted research on methods to numerically optimize microwave active circuits so as to reduce variations in performance characteristics resulting from parameter tolerances. He also studied the large-signal behaviors of microwave active diodes and techniques for employing such diodes in broadband power amplifiers. Subsequently, he held a two-year international fellowship from the Swiss National Science Foundation providing opportunity to further pursue interests in the area of nonlinear interaction between microwave active semiconductor devices and their surrounding circuits. He spent this time at Cornell University in Ithaca, NY, and at the Naval Research Laboratory in Washington, DC, concentrating specifically on nonlinear properties of GaAs field-effect transistors.

Since 1978 he has been employed at the Naval Research Laboratory in Washington, DC, where he currently heads the Solid-State Circuits Section. His research interests have remained focused primarily on nonlinear phenomena in microwave and millimeter wave active semiconductor devices. Particular topics of investigation have included the derivation of a quasi-static device model to describe the nonlinear characteristics of GaAs field-effect transistors and the development of novel circuit concepts that optimize the impact of nonlinear effects in a variety of microwave applications. Such applications include power amplification, fixed-frequency and wideband varactor-tuned fundamental frequency oscillation, frequency doubling, and frequency halving. These efforts have been balanced by linear circuit work with emphasis on microwave active filters. He has also pursued interests in the area of optical-microwave signal interaction in semiconductor devices, as exemplified by the development of a self-oscillating GaAs FET demodulator and downconverter circuit for recovering a millimeter wave modulation signal from an optical carrier. Involvement in the optical-related area has been enhanced by his recent sabbatical year at the Los Alamos National Laboratory in Los Alamos, NM, which was devoted to the investigation of new circuit approaches to the implementation of a high-speed photoconductor-based reflectometer concept for on-chip measurement of millimeter wave device characteristics.

1987
Distinguished Service Award
Kiyo Tomiyasu

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

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

The Administrative Committee of the Microwave Theory and Techniques Society has selected Kiyo Tomiyasu as the recipient of the 1987 Distinguished Service Award "for his outstanding and dedicated service to the Society."

Kiyo Tomiyasu was born in Las Vegas, Nevada on September 25, 1919. He received the B.S. degree in Electrical Engineering from the California Institute of Technology, Pasadena, in 1940 and the M.S. degree in Communication Engineering from Columbia University, New York, NY, in 1941. He studied at Stanford University, Stanford, California, under a Low Scholarship and then entered Harvard University, Cambridge, Massachusetts, where he continued graduate work with a Gordon McKay Scholarship and received the Ph.D. degree in Engineering Science and Applied Physics in 1948.

He served as a Teaching Fellow, Research Assistant, and Instructor at Harvard University. In 1949 he joined the Sperry Gyroscope Company, Great Neck, New York, as a Project Engineer, and in 1952 was promoted to Engineering Section Head for Microwave Research in the Microwave Components Department. In this capacity he was responsible for developments on ferrites, microwave components, spectroscopy and radiometers. In 1955 he joined General Electric Microwave Laboratory, Palo Alto, California, as a Consulting Engineer, and five years later he transferred to the General Electric Research and Development Center, Schenectady, New York, where he was involved with lasers and microwave projects. In 1969 he became a Consulting Engineer at General Electric Valley Forge Space Center, Philadelphia, Pennsylvania.

For the past several years he has been involved with microwave remote sensing of the earth using satellite-borne radiometers, scatterometers and synthetic aperture radar. He helped design the NASA/JSC Skylab S-193 Microwave Radiometer Scatterometer Altimeter, and he was a Principal Investigator of the NASA Langley Research Center AAFE RADSCAT sensor. On SEASAT, he was responsible for specifying the spacecraft interfaces with the scatterometer and synthetic aperture radar. Several papers on remote sensing of the earth using microwave sensors have been published and presented by him at various symposia. Recent configurations discussed have been a monostatic synthetic aperture radar from a nutating satellite in geosynchronous orbit, and a bistatic synthetic aperture radar employing two satellites. He has also worked on a conceptual design of a coarse resolution, wide swath synthetic aperture radar for imaging sea ice, oceanic oil spills and geologic features, and inferring soil moisture. He has been concerned with the propagation of microwave signals through rain, the troposphere and the ionosphere.

His total publications list over sixty papers and twenty patents have been issued in his name. In 1977 he was granted a General Electric Company Charles Proteus Steinmetz Award for outstanding individual achievement over a sustained period as evidenced by impact on the company and society. As part of this award a $5,000 stipend was designated to California Institue of Technology to be used for three annual scholarships. In 1977

Distinguised Service Award (Cont.)

Dr. Tomiyasu and his sister from Los Angeles established also at Cal Tech an annual scholarship called the "Tomiyasu Scholarship".

Dr. Tomiyasu was President of MTT-S in 1960-1961 and has subsequently served on the Nominations Committee and the Awards Committee. He was the Editor of **MTT Transactions** in 1958 and 1959, and Guest Editor of the May 1978 Special Issue of the **Transactions** on High Power Microwaves. In 1973 he was elected Honorary Life Member of MTT-S and of its Administrative Committee. He was named recipient of the 1980 Microwave Career Award by the MTT-S. In 1984, he received an IEEE Centennial Medal.

At the IEEE level, he has served on the Publications Board, the Technical Activities Board and on the Awards Board for several years. He was elected for the 1985-1986 term as IEEE Director of Division IV which embraces electromagnetics and radiation. He serves a concurrent term on the IEEE Board of Directors and as a Delegate to the IEEE Assembly.

In 1986 he was awarded an Annual Prize of the Telecommunications Association of Japan. The citation reads, "for his distinguished contributions towards the progress of telecommunication industries and for his outstanding service." He is the first non-Japanese citizen to receive the prize in its 27-year history. Dr. Tomiyasu delivered his acceptance speech at a meeting jointly sponsored by the Association and the IEEE Tokyo Section.

Dr. Tomiyasu was elected to the IEEE Fellow Grade in 1962 and became a Life Fellow in 1984. His name is listed in several biographical references among which are American Men of Science, Who's Who in Engineering, Men of Achievement, Leaders in Electronics, and Who's Who in America. He is a member of the American Physical Society.

1986-87 MTT-S Distinguished Microwave Lecturer

The First Century of Microwave - 1886 to 1986 A Historical Perspective of Microwave Devices and Their Uses

John H. Bryant

ABSTRACT

The first century of microwaves began with the historic experiments of Hertz in 1886 to 1888. It is significant that Hertz used what we now call microwave circuits and techniques. His remarkably thorough investigations opened up the electromagnetic spectrum between DC and light for scientific and practical uses. His was a step-by-step learning process, alternating between experiments and analytical work.

The presentation will start with a synopsis of major milestones leading up to Maxwell's famous 1864 article predicting electromagnetism, and summarizes activities from that time until Hertz demonstrated the validity of Maxwell's theory in 1887. Hertz's immediate successors before 1900 – more than 20 in number, in at least 9 countries – made major advances in techniques, technology and scaled their apparatus to shorter wave lengths into the millimeter range. Replicas of some of the apparatus will be shown for illustration. A brief account will be given of publications during the period prior to 1900, of people working in the field and how they interacted.

The period following 1900 was relatively slow, but after the advent of CW signal sources, Barkhausen-Kurz tubes (1920) and magnetrons (1928), along with improved technologies including detection, interest in microwaves was revived. Systems interests centered in communications and early radar experiments.

The presentation will conclude with selections from the author's study of historical records and some personal interviews with pioneers of microwave devices and their applications.

BIOGRAPHY

John H. Bryant is currently an Adjunct Research Scientist in the Department of Electrical Engineering and Computer Science, The University of Michigan, Ann Arbor. His career in the microwave field got an early start after he received his B.S.E.E., was commissioned a Second Lieutenant in the U.S. Army Signal Corps in 1942, and was sent to England for radar school and operational training. From 1943 to 1945 he served with the American forces in operational radar and communications.

Following graduate work at the University of Illinois, Dr. Bryant worked from 1949 to 1955 at ITT Laboratories in New Jersey developing traveling-wave tubes. From 1955 to 1962 he was with Bendix Research Laboratories in Michigan, working on microwave components and missile guidance systems. In 1962 Dr. Bryant was a founder of Omni Spectra, Inc., and served as its President and Chief Executive Officer. Omni Spectra microwave components and OSM miniature coaxial connectors opened up the upper half (above 10 GHz) of the microwave frequency range to coax and planar circuit construction, and accelerated the move from waveguide to compact, TEM-type designs. After the company became a part of M/A-COM, Inc., in 1980 he served as consultant to that firm until 1985. Dr. Bryant is a Fellow of IEEE and past chairman of MTT-S AdCom (1970) and the S.E. Michigan Section of IEEE (1970). He holds 14 U.S. patents, and is a member of Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and the American Physical Society.

1986-87 MTT-S Distinguished Microwave Lecturer

GaAs–Key to Modern Microwave Technology

Edward C. Niehenke

ABSTRACT

Recent advances in microwave technology can be traced to developments in GaAs devices and circuits. GaAs has found its niche for the FET, HEMT, varactor, PIN, IMPATT, and Gunn devices. Many technical breakthroughs and developmental activities using GaAs have surfaced in recent years, which has resulted in the insertion of GaAs in the modern microwave system. The system, whether communication, radar, electronic warfare, missile guidance, or commercial, has benefitted by using GaAs in the areas of reliability, efficiency, performance, speed, size as well as extending the frequency range of the system. GaAs enables smaller and lighter systems to perform many sophisticated microwave processing functions not possible with other technologies.

GaAs will be compared with other materials, and the salient properties of GaAs which benefit sthe various semiconductor devices will be highlighted. The effect of temperature and radiation will be included. The latest device technology for both discrete devices and monolithic circuits will be reviewed. The recent state-of-the-art design techniques and performance will be presented for many GaAs devices and circuits.

Techniques which are used to achieve broadband, low noise of high power, high efficiency FET amplifiers will be discussed. The FET oscillator discussion will include design synthesis and circuits for highly stable fixed tuned (DRO) and electronically tuned oscillators (VCO, YIG). Various methods to reduce the oscillator 1/f phase noise will be reported. In addition, recent two terminal Gunn and IMPATT oscillator results and circuits will be shown. To conclude the lecture, information regarding phase shifters, attenuators, and efficient, high power multiplication using GaAs will be presented.

BIOGRAPHY

Edward C. Niehenke received his BS (1961) and MS (1965) degrees in electrical engineering from Drexel University, Philadelphia, PA. In 1970 he completed additional course work in electrophysics at the University of Maryland, College Park, Maryland. In 1963, after two years of cryogenic electronics research at Martin Marietta (Baltimore), he joined Westinghouse (Baltimore) where he has been responsible for the development of low noise amplifiers, limiters, oscillators, mixers, and miniature microwave integrated circuits.

His present duties as advisory engineer for Microwave Operations of the Design and Producibility Divisions include the consultation and development of microwave circuitry for radar and ECM with emphasis on low-noise techniques. He holds five patents and has authored numerous papers on microwave circuits.

He lectures on Non-linear Circuit Design (Oscillators and Low Noise Amplifiers) for UCLA Extension and the Continuing Educational Institute and is also on the faculty of the Johns Hopkins University teaching Electricity and Magnetism in the Evening School.

Niehenke is a member of MTT-S Adcom and MTT-S Microwave and Millimeter Wave Integrated Circuits Technical Committee, and was chairman of the 1986 MTT-S International Microwave Symposium, held in Baltimore, MD. He is a senior member of the IEEE, and is a registered Professional Engineer in the State of Maryland.

1987-88 MTT-S Distinguished Microwave Lecturer

Technology Trends in Microwave Radar

David K. Barton

ABSTRACT

The capabilities of microwave devices used in today's radars are compared with requirements for future systems. Areas in which system requirements may drive technological advances are identified, along with those in which technology may open up new system approaches. An example of the former is the requirement for ultra-stable microwave sources to drive doppler radar systems operating with high power near the ground surface. To date, the only satisfactory source is a cavity-stabilized klystron oscillator operating in the final RF band. An example of the second is the modular, solid-state T/R module for small tactical radar applications. Modular arrays have, in the past, been limited primarily to large systems in the lower-frequency bands, but the prospect of greater efficiency in the microwave bands makes it possible to consider the modular approach to mobile and airborne radars.

The relationships among modular phased arrays, solid-state microwave sources and conventional antennas and transmitters are explored. There have been predictions for the past twenty-five years that reflector antenna systems would be phased out of the inventory, to be replaced first by passive arrays and then by active modular arrays. The slow rate at which these predictions have been realized is only partly explained by the high cost of phase shifters and the high cost and limited power capability of microwave T/R modules. Some of the system considerations in applying the new technology are reviewed, and areas in which applications may be most practical are identified.

BIOGRAPHY

David K. Barton joined the staff of ANRO Engineering Consultants in 1984 after serving 21 years with the Raytheon Company. Prior to that, he was with RCA at Moorestown, NJ and with the Signal Corps Engineering Labs at Ft. Monmouth, NJ and White Sands Missile Range. He is a Fellow of the IEEE and has been active in that organization's Aerospace and Electronic Systems Society, having served on the Board of Governors, as Associate Editor for Radar of the AES Transactions, and as Chairman of the Radar Systems Panel.

Barton has specialized in radar since his graduation from Harvard College in 1949 with an AB in Physics. He has authored 75 papers and books on radar engineering subjects. He is the author of ***Radar System Analysis***, and coauthor of the ***Handbook of Radar Measurement***, both published by Artech House. David Barton is also the series editor of the Artech Radar Library, which includes a seven-volume set on ***Radars***. He is a lecturer on radar in the The George Washington University's program on Continuing Engineering Education, and has served on a number of advisory committees to the Department of Defense. In 1958 he received RCA's David W. Sarnoff Award for outstanding achievement in engineering, in 1961 the IEEE PGMIL M. Barry Carlton Award, and in 1984 the IEEE Centennial Medal.

1987-88 MTT-S Distinguished Microwave Lecturer

CAD of Hybrid and Monolithic Microwave & Millimeter-Wave ICs

Rolf H. Jansen

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 therof, 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 models 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.

BIOGRAPHY

Rolf H. Jansen received his MS (1972) and Ph.D. (1975) degrees, both in electrical engineering, from the University of Aachen (RWTH). In his thesis he treated large-signal bipolar transistor modeling and the hybrid-mode analysis of arbitrarily-shaped microstrip structures, respectively. He continued his research work at the RWTH Aachen microwave laboratory as a Senior Research Engineer (1976-1979) where he was mainly engaged in the characterization of MIC components and the CAD of microwave circuits. He was also in charge of the thin-film technology of the microwave lab and since 1977, worked as a research associate for radio communication at Standard Elektrik Lorenz AG (SEL) in Pforzheim, West Germany.

In 1979, he became Professor of Electrical Engineering at the University of Duisburg near Düsseldorf/Cologne and did teaching and research on such topics as electromagnetic theory, microwave techniques and CAD, measurement techniques and modeling. His university career was supplemented by a one year's leave 1981/1982 as a full-time scientist with SEL Pforzheim, and by a variety of software and hardware projects for the communication industry since 1976. He developed, introduced and tested the first layout-oriented general purpose microwave CAD package in a West Germany production-oriented industry environment. He is author of 55 technical papers in the field of microwave CAD and related topics and recipient of the outstanding publications award in 1979 of the German Society of Radio Engineers.

Presently, with a preparatory phase since the end of 1984, he is engaged in the development of a novel engineering CAD workstation for GaAs MMICs with Plessey Research Caswell, GB, following completely new design concepts. He is co-founder of MCAD Software and Design Corp. in Aachen and owner of another small microwave company. He is a Senior Member of the IEEE, member of the editorial board of the Transactions on MTT and of two MTT Technical committees. He is serving as the West Germany MTT Chapter Chairman for the period 6/85 to 5/87.

1987 IEEE Fellow Awards

Twenty two members of the Microwave Theory and Techniques Society were elected Fellow, IEEE. Of these, seven were evaluated by MTT-S. The names and citations for these seven are listed Below.

Dr. Ali E. Atia	*For developments in microwave filter design for communications satellites.*
Professor Fred E. Gardiol	*For contributions to the design of ferrite microwave devices.*
Dr. Bernard Glance	*For contributions to the advancement of phase-locked circuits in communication systems.*
Dr. Kazuhiro Miyauchi	*For contributions to the development and application of high speed digital transmission technology in communications.*
Dr. Adel A.M. Saleh	*For contributions to the theory of microwave mixers.*
Dr. C. Burke Swan	*For contributions to the application of microwave and optical devices.*
Dr. Albert E. Williams	*For contributions to the theory and development of dual-mode, optimal performance microwave filters.*

The names and citations for those MTT-S members who were evaluated by another society are given next. The evaluating society is also noted.

Dr. Nicoloas G. Alexopoulos, AP	*For contributions to the understanding of substrate-superstrate effects on printed circuit antennas and integrated microwave circuits.*
Dr. J. Robert Ashley, IM	*For engineering low-phase noise microwave oscillators.*
Prof. Keith G. Balmain, AP	*For contributions to the understanding of log-periodic antennas in plasma.*
Dr. David M. Bloom, LEO	*For contributions to nonlinear optics and ultrafast optoelectronics.*
Dr. Donald M. Bolle, OE	*For contributions to nonreciprocal components for microwave and millimeter-wave systems.*
Dr. Edward C. Dufort, AP	*For contributions to microwave engineering of low sidelobe multiple beam antennas, geodesic antennas, modularized active-phased arrays, and limited scan antennas.*
Dr. Edmond S. Gillespie, AP	*For contributions to electrical engineering education and standards.*
Mr. Edward J. Glenner, COMM	*For contributions to the digitization of the United States public telephone network.*
Dr. Dean T. Hodges, LEO	*For contributions to laser engineering including co-invention and development of the optically pumped far-infrared waveguide laser.*
Dr. Charles M. Knop, AP	*For developments in high-gain low-sidelobe, microwave reflector antennas for satellite communication earth stations and multiband terrestrial radio relay systems.*

IEEE Fellow Awards (Cont.)

Dr. Hans J. Liebe, AP	*For contributions to the quantitative understanding of the radio frequency properties of air up 1000 GHz*
Dr. Toshio Sekiguchi, AP	*For research contributions to antennas and electromagnetic wave theory.*
Prof. Liang-Chi Shen, AP	*For contributions to antenna theory and the application of electromagnetics to geophysical exploration.*
Mr. Peter I. Somlo, IM	*For contributions to precision metrology at radio and microwave frequencies.*
Prof. Donald R. Wilton, AP	*For contributions to numerical techniques for solving electromagnetic scattering, radiation, and penetration problems.*

Three new Fellows will receive their certificates at the Symposium Awards Banquet. They are Ali E. Atia, Donald M. Bolle and Albert E. Williams. We look forward to that occasion.