Session TPM: Microwave Integrated Circuits-II

"Coplanar Waveguide Directional Couplers," C. P. Wen (RCA Laboratories, Princeton, N. J.).

Session WAM-1: Gunn-Effect Devices

"*C*-Band and *X*-Band Varactor Tuned Gunn-Diode Oscillators," R. Ruttenberg (Kruse Electronics, Mountain View, Calif.).

Session WAM-2: Guided Waves and Stripline

"A Model Solution of the Microstrip Transmission Line," L. G. Heller (IBM Corporation, Essex Junction, Vt.) and R. E. Post (Iowa State University, Ames).

Session WPM-2: Microwave Acoustics

"Some Effects of Ambient Temperature on Surface Wave Linear FM Correlator Performance," R. A. Kempf, W. S. Jones, and C. S. Hartman (Texas Instruments, Inc., Dallas, Tex.).

Digest

The *Digest* retained the now standard 5½- by 8½-inch size and was enhanced by the "Southern California—View from Apollo 9" picture on the cover. Copies should still be available from IEEE Headquarters as IEEE Catalog 70C10-MTT.

Social Functions

As usual the social functions included an old-acquaintance party on the evening before the start of the Symposium as well as a cocktail party prior to the banquet later in the week.

The attendance at the banquet of only 175 people was somewhat less than in prior years, but this number made up in conviviality what it lacked in numbers. Robert Krausz, Master of Ceremonies, kept the banquet attendants in good humor through head-table introductions. Recognition of Symposium committee members, a brief address, and awards were presented by John Bryant. Leo Young, Past ADCOM Chairman, was presented with a certificate, Richard Damon received the 1969 G-MTT National Lecturer Award, and John Rhodes was presented with the Microwave Prize for two papers in the April, 1969, MTT Transactions.

The scheduled banquet speaker, Dr. Harold I. Ewen, unfortunately became seriously ill just prior to the Symposium. However, Prof. Marshall Cohen of the California Institute of Technology, Pasadena, was available as a very adequate substitute and addressed the gathering on "Advances in Radio Interferometry." His talk on the recent progress made in this field was both amusing and informative.

Ladies Program

The ladies ran a well-organized and well-received program this year with 25 full-time attendants and several others who joined in for a few of the activities.

Conclusion

Several arrangements from previous years were either maintained or reinstituted. The four-day meeting with parallel sessions and evening meetings is perhaps one of the more controversial items. Pros and cons can be and have been expressed on this matter; perhaps a reasonable compromise is a four-day meeting with fewer parallel sessions and consequently fewer scheduled papers, but with a free afternoon to permit informal interchanges in a more relaxed manner. The inclusion of selected late news items is an excellent idea and worked out very well. The "hang-up" discussion is still considered a good idea and is worth another try.

Despite present difficulties and an uncertain future, it is evident that there is still much vitality and interest in the microwave field. Certainly this year's Symposium, which took as its theme "Microwaves—The Fourth Decade," demonstrated that the past is indeed only a prelude to the future.

The 1970 G-MTT National Lectureship

The G-MTT National Lectureship was initiated in 1967 specifically to provide assistance to chapters experiencing difficulty in planning technical programs by providing a prominent speaker on a current microwave topics. Emphasis is placed on aiding new chapters and small chapters located in areas where speakers are not readily available. The goals established for the National Lectureship are to stimulate chapter growth, provide a greater dissemination of current technical information, and establish stronger bonds between the chapters and the National Group. A budget of $2000 per year is provided to cover, or partially defray, the expenses of the National Lecturer. Typically, the National Lecturer will speak at 10–15 chapters during his one-year tenure. Past Lecturers are Richard W. Damon (1969), Leo Young (1968), and Arthur A. Oliner (1967). The 1970 National Lecturer is Harold Sobol, RCA Research and Engineering, Princeton, N. J. The lecture summary follows.

Microwave Integrated Circuits A Summary of the 1970 G-MTT National Lecture

During the past several years, integration has been introduced into the microwave bands, and the feasibility of performing practically every medium- and low-power microwave function with microwave integrated circuits (MICs) has been demonstrated. The major reasons for the move towards integration are increased reliability, improved reproducibility, smaller size, improved performance, and a potential cost savings. At this time hybrid integration is used almost exclusively.

There are two general classes of circuits that can be used for MICs: distributed circuits as microstrip, suspended substrate, slotline, and coplanar waveguides, and lumped elements as inductors and capacitors. The various circuit forms are compared and ranked according to size, cost and reliability, reproducibility, and losses. The unloaded Qs achieved in any form of MIC are at least an order of magnitude less than conventional circuitry.

The technology of hybrid integration for MICs is discussed and information is presented on substrate, conductor, resistor, and dielectric materials. Thin- and thick-film approaches are compared. The effect on overall loss of both substrate finish and multilayer metal films (Cr–Au, Cr–Cu, Ta–Au, etc.) is discussed. The practical considerations entering into the choice of a material system for microstrip and lumped-element MICs are presented.

Design information for microstrip propagation based on TEM solutions for frequencies through S-band and based on mixed mode propagation for higher frequencies is given. Characteristic impedance, wavelength, loss, and the effect of metal boundaries are discussed. Design equations for typical microwave lumped inductors, capacitors, and resistors are presented. The effect of parasitic reactances encountered when utilizing lumped elements is considered. Methods of accurately characterizing small- and large-signal active devices for use in MICs are discussed.

Representative examples, fabricated by various companies, are shown as illustrations of the various techniques used for MICs. Lumped-element transistor amplifiers covering the 100 MHz to 2.4 GHz frequency range are shown. Both linear and large-signal amplifiers are included. Microstrip transistor amplifiers operating up to 5.6 GHz are shown. Microstrip receivers, phase-shifters, transmit–receive modules, circulators, and paramps are also discussed. Performance data on all examples are given.

The future for the application of MICs is bright. About the only functions that will be difficult or impossible to realize with MICs are the generation of high power and narrow-band low-loss filtering. High power, however, can be achieved by incorporating an ensemble of MIC transmit–receive modules into a phased-array system. The MERA system is the prime example of this approach, and at the present time several more advanced radars are under study.

——Harold Sobol

Harold Sobol (S'57–M'59–SM'69) was born in Brooklyn, N. Y., on June 21, 1930. He received the B.S.E.E. degree from City College of New York, New York, and the M.S.E. and Ph.D. degrees in electrical engineering from the University of Michigan, Ann Arbor.

From 1952 to 1955 he worked on radar and guidance programs at Willow Run Laboratories, University of Michigan. From 1955 to 1959 he was a Research Associate studying nonlinear operation of traveling-wave tubes and electron-beam parametric amplifiers at the Electron Physics Laboratory, University of Michigan. In 1960 he joined the staff of the IBM T. J. Watson Research Center, Yorktown Heights, N. Y., and was involved in research on super-conducting films for use in high-speed computers. He joined the staff of the Microwave Research Laboratory, RCA Laboratories, Princeton, N. J., in 1962. During 1963 and 1964 he was an Adjunct Lecturer in the Graduate School, Drexel Institute of Technology, Philadelphia, Pa., and has lectured in several RCA technical courses for management and in several summer courses at the University of Michigan. In 1963 he became Head of the Power Generation Group, RCA Laboratories, and in 1965 Head of the Microwave Integrated Circuits Group. His research has covered plasmas, klystrons, solid-state devices, and microwave integrated circuits. He served as Manager, Microwave Microelectronics, at RCA's Solid-State Division, Somerville, N. J., from 1968 until 1970. He is currently Staff Engineer, Technology, RCA Research and Engineering, Princeton, N. J.

Dr. Sobol is a member of the American Physical Society, Eta Kappa Nu, Tau Beta Pi, Sigma Xi, and Phi Kappa Phi. He held a Sperry Fellowship in Electron Physics during 1965–1966. He was a member of a team that won a 1969 IR-100 award for development of a microwave amplifier. He is listed in *Who's Who in the East* and *American Men of Science*. He is author or coauthor of 22 papers in technical journals and has presented more than 30 papers at technical meetings. He was awarded the 1970 G-MTT National Lectureship.