Guest Editor's Overview

MICROWAVE and millimeter wave systems are in common use today and their range of applications is expanding. It is safe to predict that these systems will be utilized in the future across the spectrum of endeavors from communications, radar, to transportation, industrial and scientific applications. Satisfying this expanding demand mandates the utilization of previously unused, or little used, mm-wave and sub-mm-wave bands. i.e. the use of the frequency band from 30 GHz to 3000 GHz, in accordance with a long term trend toward systems operating at higher and higher frequencies. The necessary technology, however, is not very well developed at the present time, which holds in particular for the sub-mm-wave band above 300 GHz. In addition, this technology (as far as it is available) suffers from high fabrication cost and lack of convenient power sources. Component costs have been driven by the small size and tight tolerances associated with the 100–3000 GHz band and in the case of conventional waveguide components, by the need for hand assembly. Power sources were largely limited in the past to vacuum tubes requiring high primary power, and, again, restrictive tolerances. Moreover, these sources are liable to catastrophic failure. Solid state sources are more reliable but their output power tends to be very low at frequencies above 100 GHz due to the small physical size of the active region, resulting in the well-known $1/f^2$ fall-off of available power. Hence a need exists to combine the outputs of many individual elements to satisfy the system power requirements.

Many of the problems stated above may be resolved through the use of quasi-optical techniques. Quasi-optical devices typically have cross sectional dimensions in the order of 10 to 100 wavelengths and are relatively easy to fabricate. Tolerance requirements are greatly relaxed since boundary surfaces along the propagation directions of the guiding structure are not critical for mode selection and maintenance of mode purity. Rather, easily manufactured lenses or reflectors, and their spacing between them, establish the mode parameters. In addition, the rather large transverse dimensions of quasi-optical structures allow one the freedom to include numerous solid state sources or control elements to achieve the desired output power or control function. During the past several years, significant progress has been made in the area of quasi-optical techniques. New passive components such as waveguides and antennas have been suggested and experimental models of new active devices have been demonstrated including distributed mixers, frequency multipliers, phase shifters, amplifiers and power combiners. Typically these active devices include a planar diode or transistor array containing many solid state devices whose functions are combined quasi-optically. Complementing these experimental accomplishments, a variety of theoretical approaches has been developed for the design and characterization of quasi-optical components and systems. Much of this pioneering work has been presented at workshops and professional society meetings. Because of the technical importance of these developments it appeared timely to devote a Special Issue of the MTT Transactions to this subject. The issue is focused on quasi-optical techniques that will allow achieving reliable, easily manufactured, low-cost devices and systems for the mm-wave and sub-mm-wave bands.

The call for papers for the Special issue found a strong response as evidenced by the volume of this issue. The Special Issue has been organized in five major sections. An *Invited Overview* that focuses upon imaging systems employing quasi-optics is provided in the paper entitled "Focal Plane Imaging Systems for Millimeter Wavelengths". The overview is followed by four sections. The first two sections address passive quasi-optical components and systems. The final two sections address quasi-optical systems of active components.

I. The first, addressing *Gaussian Beams* containing five papers: "Long-Wave Optics". Gaussian Beam-Mode Analysis and Phase-Centers of Corrugated Feed Horns", "Mode Conversion at Diffracting Apertures in Millimetre and Submillimetre Wave Optics", "Slot-Fed Higher Order Mode Fabry-Perot Filters", and "Guassian-Beam Open Resonator with Highly Reflective Circular Coupling Regions".

II. The next section addresses *Quasi-Optical Antennas and Waveguides* also containing five papers: "Tapered Slotline Antennas at 802 GHz", "A Hybrid Dielectric Slab-Beam Waveguide for the Sub-Millimeter Wave Region", "A Planar Wideband 80-200 GHz Subharmonic Receiver", "Double-Slot Antennas on Entended Hemispherical and Elliptical Dielectric Lenses", and "An Improved Solution for Integrated Array Optics in Quasi-Optical MM and SubMM Receivers: the Hybrid Antenna".

III. This section focuses upon *Active Grid* arrays and again contains five papers: "A 100-Element HBT Grid Amplifier", "A 6.5 GHz to 11.5 GHz Source using a Grid Amplifier with a Twist Reflector", "Quasi-Optical VCO's", "A Monolithic Millimeter-Wave Diode Array Beam Transmittance Controller", and "Quasioptical Millimeter Wave Hybrid and Monolithic PIN Diode Switches".

IV. The final section containing eight papers addresses *Quasi-Optical Coupled Oscillators:* "Nonlinear Analysis of Phase Relationships in Quasi-Optical Oscillator Arrays", "A New Phase-Shifterless Beam-Scanning Technique Using Arrays of Coupled Oscillators", "Impedance Matrix of an Antenna Array in a Quasi-Optical Resonator", "Mode Analysis and Stabilization of a Spatial Power Combining Array with Strongly Coupled Oscillators", "Quasi-Optical Planar Arrays of FETs and Slots", "A 60 GHz IMPATT Oscillator Array with Pulsed Operation", "Millimeter and Submillimeter Wave Quasi-Optical Oscillator with Gunn Diodes", and "Active Inverted Stripline Circular Patch Antenna for Spatial Power Combining".

We hope that this issue will provide not only state-of-the-art information but a perspective on a fast developing and diverse field.

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The editors want to thank the reviewers for their participation in the paper evaluation process and for their constructive comments, which many authors acknowledged as a valuable help in the preparation of their final manuscripts. We sincerely appreciate the reviewers' efforts.

JAMES W. MINK
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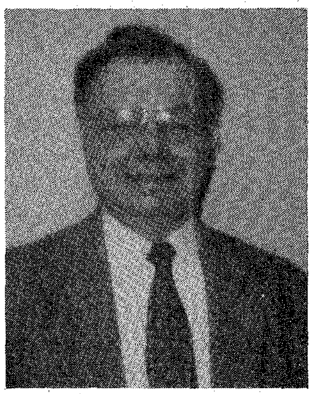
Guest Editors



Dr. James W. Mink (S'59–M'65–SM'81–F'91) joined the U.S. Army Research Office in 1976, where he currently serves as Director of the Electronics Division. In addition, he continues to direct an extramural research program in electromagnetic theory and millimeter wave integrated circuits and devices and is the principle Army representative of the Joint Services Electronics Program (JSEP). From 1984–1990, he served as the Associate Director of the Electronics Division. During 1982, he served as an intern in the Office of the Army Deputy Chief of Staff for Research, Development and Acquisition. Since 1979 he has been an Adjunct Associate Professor at North Carolina State University, teaching electromagnetics and microwave theory, and conducting research on millimeter wave devices and antennas. He continues to serve as committee chairman, session chairman, and panelists for numerous conferences and workshops and is a Fellow of the Institute of Electrical and Electronics Engineers. He serves as an evaluator of University Departments of Electrical Engineering for the Accreditation Board for Engineering and Technology. From 1964 through 1975, he was engaged in research at the U.S. Army Electronics Command, Fort Monmouth, NJ. During this time, he performed basic research on free space and guided propagation of electromagnetic waves on electrically small antennas. Dr. Mink received the B.S., M.S., and Ph.D. degrees in electrical engineering in 1961, 1962, and 1964, respectively, from the University of Wisconsin, Madison.

David B. Rutledge (M'75–SM'89–F'93) received the B.A. degree in mathematics from Williams College, Williamstown, MA, in 1973, the M.A. degree in electrical sciences from Cambridge University, Cambridge, England, in 1975, and the Ph.D. degree in electrical engineering from the University of California at Berkeley in 1980. In 1980 he joined the faculty at the California Institute of Technology, Pasadena, CA, where he is now Professor of Electrical Engineering. Previously he designed microwave datalink systems as an Aerosystems Engineer at General Dynamics Corporation, Fort Worth, Texas, from 1975 to 1976. He was a visiting scientist at CSIRO, New South Wales, Australia, in the summer of 1985, and at the Research Institute for Electrical Communication, Tohoku University, Sendai, Japan, in the spring and summer of 1988. His research is in developing microwave and millimeter-wave integrated circuits and applications, and in software for computer-aided design and measurement. He is co-author with Scott Wedge and Richard Compton of the software CAD program, *Puff,* which has over 10 000 users worldwide. He is a winner of the NSF Presidential Young Investigator Award and the Japan Society for the Promotion of Science Fellowship. He has been a Distinguished Lecturer for the Antennas and Propagation Society, and is a winner of the 1993 Microwave Prize.

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