Foreword

MICROWAVE AND millimeter-wave integrated circuits of increasing complexity and component density have been designed in recent years and are needed in the future for a wide variety of applications in computers, communications, sensing, signal processing, etc. Elaborate analytical and computational techniques are required for the characterization and synthesis of these circuits. The first step in a systematic approach to this problem is an accurate theoretical description of the basic building blocks from which these circuits are constructed, i.e., of microwave and millimeter-wave transmission media and active and passive components, including their mutual interaction in an integrated-circuit environment. There are several problem areas here where basic contributions to the state-of-the-art are needed. To name a few: the description of the effects of substrate anisotropy on the performance of open and shielded waveguides; the characterization of transitions and discontinuities in microwave/millimeter-waveguides, to include the case of active components monolithically integrated in these guides; and the accurate description of the effects of finite conductivity on the current distribution and losses in the metal parts of millimeter-wave transmission lines, in particular when the metallization thickness is in the order of or smaller than the skin depth. The complexity of these problems usually does not allow the development of analytical solutions, and advanced numerical methods are needed. Basic requirements on such methods include high accuracy — or at least controlled accuracy — and numerical efficiency. Moreover, while these techniques will always involve numerical evaluations, they should not degenerate into brute force computer methods. It is desirable that they can be carried through to a large extent analytically in order to facilitate physical understanding of the phenomena involved.

During the past several years, significant progress has been made in the area of numerical methods, and a variety of advanced techniques using different approaches has been developed for the design and characterization of microwave/millimeter-wave transmission media and integrated circuits. These techniques are based on such diverse methods as modal techniques, spectral-domain methods, variational and iterative schemes, moment method techniques, high- and low-frequency approximations, time-domain techniques, network and transmission-line representations, and differential equation approaches such as the finite-difference and finite-element methods. For an engineer who has to solve a specific problem, the question arises as to which method is best suited for his application and what are the advantages and fundamental limitations of the chosen method.

Thus, it appeared desirable to summarize and assess recent progress in this area. In conjunction with last year's MTT Symposium in San Francisco, a workshop entitled "Critical Inspection of Field-Theoretical Methods for Microwave Problems" was organized by Dr. T. Itoh and chaired by one of the editors of this Special Issue (J. W. M.). The conference was held on May 29, 1985, and a number of keynote papers were presented highlighting problem areas of fundamental importance and broad perspective. The workshop was well attended and led to a lively, thought-provoking exchange of ideas on the topic of numerical methods, indicating a strong interest in this area within the MTT community. In light of this, it was regarded timely to devote a Special Issue of the MTT Transactions to this subject. The keynote papers of the workshop appear in this issue in expanded form as invited papers.

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 four major sections. It contains thirteen papers on numerical methods for the characterization of *uniform microwave and millimeter waveguides*. There are nine papers on the characterization of *transitions and discontinuities in open and closed waveguides*, and four papers on the numerical description of *planar integrated circuits*. A final group of three papers discusses numerical techniques for *related problems* including metal losses in millimeter-waveguides, planar periodic structures, and ferrite thin films. We hope that this issue will provide not only state-of-the-art information but a perspective on a fast developing and diverse field.

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:

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In addition, we would like to thank Dr. Itoh, the Chief Editor of the MTT Transactions, for his encouragement and his advice in organizing the review process for this Special Issue.

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FELIX K. SCHWERING
Guest Editors

James W. Mink (S'59–M'65–SM'81) was born in Elgin, IL, on April 23, 1935. He received the B.S., M.S., and Ph.D. degrees in electrical engineering in 1961, 1962, and 1964, respectively, form the University of Wisconsin, Madison.

In 1976, he joined the Army Research Office, Research Triangle Park, NC. He is now the Associate Director of the Electronics Division, with overview responsibility for the entire program and continues to direct an extramural research program in electromagnetic theory, millimeter waves, and antennas. From 1964 to 1975, he was engaged in research at the U. S. Army Electronics Command, which subsequently became the U. S. Army Communications Research and Development Command, Fort Monmouth, NJ. During this time, he performed basic research on free space and guided propagation of electromagnetic waves and on electrically small antennas.

Dr. Mink is a member of URSI (Commission B), Eta Kappa Nu, and Sigma Xi.

Felix K. Schwering (M'60) was born on June 4, 1930, in Cologne, Germany. He received the Dipl. Ing. degree in electrical engineering and the Ph.D. degree from the Technical University of Aachen, Aachen, West Germany, in 1954 and 1957, respectively.

From 1956 to 1958, he was Assistant Professor at the Technical University of Aachen. In 1958, he joined the U. S. Army Research and Development Laboratory in Fort Monmouth, NJ, where he performed basic research in free space and guided propagation of electromagnetic waves. From 1961 to 1964, he worked as a Member of the Research Staff of the Telefunken Company, Ulm, West Germany, on radar propagation studies and missile electronics. In 1964, he returned to the U. S. Army Electronics Command, Fort Monmouth, NJ, and has since been active in the fields of electromagnetic-wave propagation, diffraction and scatter theory, theoretical optics, and antenna theory. Recently, he has been involved, in particular, in millimeter-wave antenna and propagation studies.

From 1969 to 1978, he was leader of the Antenna Research Team of the Center of Communication Systems at Fort Monmouth and since 1979 has been a member of the Research Council of this Center.

Dr. Schwering is a Visiting Professor at Rutgers University and a member of Sigma Xi. He is a member of URSI, Commission B, and recipient of the 1961 and 1982 Best Paper Awards of the IEEE Antennas and Propagation Society (jointly with G. Goubau). At the present time, Dr. Schwering is working at the U. S. Army Research Office, Research Triangle Park, NC, under the Visiting Laboratory Associates Program.