Introduction

About This Special Issue

THIS TRANSACTIONS celebrates the 50th anniversary of the IEEE Microwave Theory and Techniques Society (IEEE MTT-S). The IEEE MTT-S has advanced the state-of-the-art of microwaves over the past 50 years in many remarkable ways. This TRANSACTIONS is the focus and premier international publication in the field. When planning this special issue, I had in mind the senior or graduate student and the general engineering manager, as well as anyone who wants a "bird's eye" view of the microwave scene and heritage. Above all, the papers herein are intended to stimulate as well as to inform.

What Then Are Microwaves?

The microwave spectrum is generally defined as that part of the spectrum wherein electromagnetic waves have wavelengths measured in centimeters, corresponding to frequencies from 3–30 GHz. However, microwave theory and techniques (the subject of this TRANSACTIONS) reach at least a decade below and a decade above the "official" microwave decade, thus encompassing something like three decades, from 300 MHz to 300 GHz. At the same time, it must be said that microwaves have greatly benefited from RF techniques developed below, and from quasi-optic techniques developed above microwave frequencies.

Beyond Electromagnetics

Microwaves may also be elastic (acoustic), magnetic (e.g., spin waves), etc., or some combination thereof. Such wavelengths are much smaller (in proportion to the much slower velocities), hence, extremely small filters and signal processors are possible. Microwave techniques have spilled into optics: witness fiber-optic waveguides, and the invention of the laser based on earlier work on the maser.

What Is Special About Microwaves?

Electromagnetic waves at microwave frequencies have attributes that make them particularly suitable for certain applications. Wavelengths of the order of centimeters fit humans and human-sized objects, which make them attractive for radar and navigation. Microwaves have the largest absolute bandwidths of any RF waves before serious atmospheric attenuation sets in; they are, therefore, useful for wireless traffic. Absorption in certain materials, especially water, is the basis for microwave industrial heating, cooking food, and medical treatment. By the same token, however, large uncontrolled doses of microwave radiation, just like overexposure to the sun, can lead to overheating in organs not served by blood vessels to carry away the heat, as from the eyes. Digital and signal processing techniques have reached microwave frequency speeds. At the time of writing, Intel has just announced its first 2-GHz chip.

Military Beginnings and Civilian Fallout

The microwave industry has gone through some ups and downs over the past 50 years. Originally (and still partially) driven by military needs, particularly radar and electronic warfare, microwaves have now burst on the civilian scene and created the huge new industry of wireless communications. The U.S. Navy's needs for accurate navigation at sea resulted in the global positioning system (GPS), now available to anyone traveling by air, land, or water; it has even been used on robots looking for survivors under the rubble of the destroyed World Trade Center.

Organization and Character of This Special Issue

Papers in this special issue are arranged in eight sections, beginning with history. Technology areas follow, from system applications to building blocks (materials and devices, components and subsystems). Related matters are then addressed (nearby frequencies, radiation, design, and performance). Infrastructure topics complete the picture (views from academia, industry and government, and international activities). A few papers include personal experiences, combining historical and personal accounts with scientific and technical insights, showing how technological progress may sometimes have to overcome both human and technical obstacles. All in all, I hope this special issue provides a sense of the breadth and depth of activities in and around microwaves over 50 exciting years.

Acknowledgment

This special issue would not have been possible without the experienced assistance from a distinguished guest editorial board. It consisted of seven guest section editors (in order of appearance of their respective sections) K. Tomiyasu, D. Parker, T. Itoh, R. Snyder, D. Rutledge, J. Harvey, M. Golio (two sections), and four members-at-large, J. Mink, R. Pollard, R. Trew, and T. Saad. Special thanks go to all of our invited authors whose biographies are collocated with their respective papers. I am particularly grateful to the Basic Research Office, Office of the Secretary of Defense, Arlington, VA, for providing the time and resources for this project, to F. Smith, Army Research Office, for help with organizing this project, and to Dr. J.-E. Turner for many useful suggestions. Staff Senior Editor Christina M. Rezes and members of the IEEE Transactions/Journals Department were consistently helpful.

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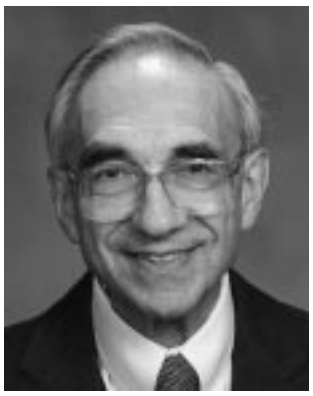

Leo Young (M'54–SM'56–F'68–LF'92) received the M.Sc. degree and Ph.D. in electrical engineering from the Johns Hopkins University, Baltimore, MD.

He retired as Director for Research in the Office of the Secretary of Defense, in 1994, and has been consulting for that office since 1997. He is particularly interested in wireless communications and, since 1994, has consulted for Filtronic plc, an international company based in the U.K., which manufactures wireless components and subsystems. Prior to 1981, he held senior positions at the Naval Research Laboratory, the Stanford Research Institute, and the Westinghouse Electric Corporation. He was a Distinguished Lecturer at The University of Leeds, Leeds, U.K. and a Visiting Professor at the Israel Institute of Technology, Haifa, Israel. He has given courses at Stanford University, Stanford, CA, and at the Marconi Institute, Bologna, Italy. He has authored, co-authored, or edited 14 books, mostly on microwave topics, and over 100 engineering papers. He holds 20 patents. He also co-authored a book with his wife on pension reform.

Dr. Young is a Fellow of the American Association for the Advancement of Science and of the U.K. Royal Academy of Engineering. He is a member of the Massachusetts Institute of Technology (MIT) Electromagnetics Academy and the U.S. National Academy of Engineering. He was president of the IEEE Microwave Theory and Techniques Society (IEEE MTT-S) and is an honorary life member of its Administrative Committee. He served on the IEEE Board of Directors for eight years and was the 1980 IEEE president and chairman of the Board. He has served on the Johns Hopkins University Advisory Committee to the School of Engineering for six years. He served on the Electrical Engineering Advisory Board of the University of California at Santa Barbara. He was chairman of the National Science Foundation's (NSF) first Engineering Advisory Committee and has served on numerous Government committees. He holds honors degrees in mathematics and in physics from Cambridge University, Cambridge, U.K. He was the recipient of an honorary Doctorate of Humane Letters and the Woodrow Wilson Award for Distinguished Government Service in 2000. He was also the recipient of the Microwave Prize and Microwave Career Award of the IEEE MTT-S.