Foreword

SPECIAL ISSUE ON MICROWAVE CONTROL DEVICES FOR ARRAY ANTENNA SYSTEMS

DURING the past ten years, need for phased array antennas for radar, communications, and electronic warefare systems has promoted extensive effort in the development of fast switching ferrite and diode phase shifters. This effort has resulted in many good papers. The goal of this Special Issue is to survey the present state of the art in diode and ferrite phasers through invited papers and to consider new innovations in these areas through contributed papers.

Present emphasis for both diode and ferrite phasers is on producing quantities of phaser elements to satisfy specific systems needs at acceptable cost levels. Acceptable cost level may be defined as cost levels which make a phased array approach cost competitive with other alternate approaches. In any array application the system functions to be performed must be sufficiently complicated to justify the cost entailed in fabricating and maintaining the array.

Once a system designer has determined the necessity of using a phased array, the choice of diode or ferrite phaser elements should be determined by system requirements. Ferrite phasers are not suited generally for use at frequencies below 3 GHz and diode phase shifters are generally not suited for use above 15–20 GHz. Diode phasers are often lighter than their ferrite counterpart but are usually restricted to use at moderate peak and average power levels. Ferrite phasers utilize variations in transmission properties of partially magnetized ferrimagnetic materials while diode phasers utilize changes in lumped reactances obtained by switching a dc voltage bias on a high frequency diode. The characteristics of state-of-the-art diode and ferrite phasers are well represented by the papers included in this Special Issue.

The papers in this issue are divided into the following categories.

1) Systems Consideration: In a single invited paper, Long describes how phase shifter cost can serve as a selection criterion in a specific system. It should be pointed out that similar studies are required for other types of systems and that in some systems cost may not be the sole determining parameter.

2) Ferrite Phasers: In this section, six papers are included. Two of these papers are concerned with the dual-mode reciprocal phaser, three are concerned with nonreciprocal toroidal phasers, and one paper is concerned with the analysis of periodic loading in nonreciprocal toroidal phasers. The invited paper by Boyd presents comments on the design and manufacture of large numbers of dual-mode phasers designed to operate in the 9–10-GHz frequency band. A related paper by Duputz and Priou presents a computer analysis of microwave propagation in ferrite loaded circular waveguide. Papers by Charlton and by Landry *et al.* are concerned with the design and manufacture of toroidal nonreciprocal elemental phasers. The paper by Moore *et al.* is concerned with the development of a high average power S-band-toroidal nonreciprocal phaser. This type of phaser could be used in switches or could be used in single axis scan antennas. The final paper in this section by Kharadly presents a detailed analysis for nonreciprocal transmission lines periodically loaded with thin metallic diaphragms.

3) Ferrimagnetic Materials: In this section, three invited papers are included. Two of these papers by Green and Sandy are concerned with the microwave characterization of partially magnetized ferrimagnetic materials. The third paper by Argentina and Baba presents an overview of microwave lithium ferrites. Lithium ferrites are becoming quite important in phaser application at frequencies above about 4 GHz. Here they offer improved electrical performance and reduced cost when compared with phasers using yttrium iron garnet materials.

4) Diode Phasers: Four papers are included in this section. Two papers are invited and two are contributed. In the first invited paper, White presents an overview of diode phase shifter technology and lists data for several elemental diode phasers. In the second invited paper, Burns *et al.* discuss low cost design techniques for S-band and UHF phasers. In addition, two types of new semiconductor switching devices are described. In one of the contributed papers, Terrio *et al.* describe the design of a low cost diode phaser for use in airborne phased array antennas. This phaser represents a competitor to the ferrite dual-mode phaser described by Boyd in an earlier paper. The final paper in this section by Lynes *et al.* describes a broad-band switched line phaser for use over the 2–4-GHz frequency range.

5) Alternate Approach: The final paper contained in this Special Issue by Al-Aui *et al.* describes an alternate approach to beam steering in active array antennas.

It is felt that the papers contained in this issue provide a good coverage of the present activity in components for phased arrays.

The Editor wishes to thank each of the authors for his worthwhile contribution. Thanks are extended also to the well-qualified reviewers who assisted in evaluating and helping the individual authors through their comments and criticisms. The reviewers include the following.

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LAWRENCE R. WHICKER, *Guest Editor*

Lawrence R. Whicker (M'60–SM'67) was born in Bristol, Va., on October 3, 1934. He received the B.S.E.E. and the M.S.E.E. degrees from the University of Tennessee, Knoxville, in 1957 and 1958, respectively, and the Ph.D. degree in electrical engineering from Purdue University, Lafayette, Ind., in 1964.

From 1958 to 1961 he was with the Sperry Microwave Electronics Company, Clearwater, Fla., where he was concerned with the design of microwave filters and ferrite millimeter wavelength components. From 1961 to 1964 he held a Ford Foundation Fellowship at Purdue University, where he conducted research in the areas of coupled-mode theory and propagation of microwave energy in a dispersive media. From 1964 to 1970 he held various technical and management positions at the Westinghouse Defense and Space Center, Baltimore, Md., and was responsible for programs in latching ferrite phasers, microwave ultrasonics, and microwave integrated circuits. Additionally, from 1964 to 1969 he served as a part-time faculty member at the University of Maryland, College Park. In 1970 he joined the Naval Research Laboratory, Washington, D. C., where he heads the Microwave Techniques Branch of the Electronics Division. In this capacity he directs research efforts in microwave antennas, ferrite devices, microwave ultrasonics, and microwave and millimeter wave integrated circuits.

Dr. Whicker is a member of Sigma Xi, Tau Beta Pi, Phi Kappa Phi, and Eta Kappa Nu. In addition to various committee assignments for the Department of Defense, he is a member of the MTT-S Administrative Committee, Chairman of Chapter Activities, and is Chairman of the MTT-S Technical Committee on microwave ferrites.