Foreword

Special Issue on Solid-State Microwave Power Amplifiers

DURING the past 10–15 years, there has been a revolution in microwave techniques brought about by the invention, development, and application of various new microwave solid-state devices. This has paralleled, in time, other revolutions brought about by solid-state devices in other fields of electronics. During this period, the most significant of the new microwave semiconductor devices have been the varactor diode, the tunnel diode, the PIN diode, the Schottky-barrier diode, the Gunn-effect diode, and the IMPATT diode. Dramatic improvements in transistors have also occurred, pushing their useful frequency frontier above 10 GHz. Applications of these devices include several types of low-noise and power amplifiers, varactor harmonic generator power sources, variable attenuators, phase shifters, microwave switches, oscillators, tuning elements, detectors, frequency converters, and modulators. Some of these devices appear to be useful at frequencies as high as 100 GHz.

For frequencies above 4 GHz and for powers greater than a few tenths of a watt, useful microwave amplifiers have appeared only recently. There are many applications for such devices, perhaps the most important being in the field of communications. Many workers are now engaged in development of practical amplifiers for such system use at these frequencies. The IMPATT negative resistance diode appears to be receiving the most attention at this time. However, Gunn-effect amplifiers have also been reported, and it appears possible that transistor power amplifiers will receive more attention in the future for frequencies up to and above 10 GHz.

This Special Issue is devoted to these developments, and was planned to facilitate communication among the many workers in this important field. There is often a long road between a laboratory demonstration of a "working" device and a fully "developed" one which will meet necessary system specifications. Our objective here is to publish work of an engineering nature, dealing with network and device design and the relationship of these to the performance achievable. It was our intent to avoid work of a preliminary or research character.

In scanning the issue, it will be noted that most of the papers treat IMPATT diode devices used in both the "linear" and the "locked-oscillator" modes of operation. There are also papers on transistor and Gunn-effect (transferred-electron) amplifiers. This unbalance represents the distribution of the papers submitted and should not be interpreted to imply a corresponding degree of importance. Particularly, it should be noted that transistor power amplification is a relatively mature field for the lower frequency bands, while for the higher bands power transistors are not yet well developed. This editor expects to see, in the future, continued advances in the frequency range and power capabilities of transistor amplifiers. Gunn-effect power amplifier development is receiving less attention at this time because of the relatively low efficiency of the available devices.

The papers in this issue can be divided into the following categories.

1) *Transistor Power Amplifiers:* In a single paper of this category, Pitzalis and Gilson deal with the difficult area of device and circuit characteristics in the nonlinear regime, and illustrate techniques for broad-band network design.

2) *IMPATT Device and Circuit Characterization:* In the comprehensive second paper, Laton and Haddad present both analysis and experimental verification to provide an understanding of the nonlinear response characteristics of IMPATT power amplifiers. Peterson's paper provides an experimental technique for characterizing IMPATT diodes and amplifier networks for millimeter wavebands. In his paper, Gupta has described a new large-signal equivalent circuit useful in nonlinear analysis of IMPATT amplifiers and oscillators. In his paper, Hansson analyzes some of the bistable hysteresis effects and the onset of some forms of IMPATT network instability. Kuno's paper discusses certain dynamic nonlinear effects in IMPATT diode amplifiers and locked oscillators; including transient response and switching time, and their relationship to bandwidth.

3) *Operating Characteristics of IMPATT Power Amplifiers:* In the paper by Kuno and English, experimental performance characteristics are presented for millimeter wave amplifiers and locked oscillators. Willing's paper describes a highly developed power amplifier for communication system use and provides detailed measurements of its performance at various frequencies and power levels. In their paper, Paik *et al.* describe a multistage IMPATT amplifier used for the transmission of phase-shift-keyed digital signals, and present data on the error rates achieved. The paper by Komizo *et al.* describes a new technique for the reduction of intermodulation distortion in an IMPATT amplifier. The paper by Yarrington and Hawkins presents data on temperature effects in IMPATT power amplifiers.

4) *Gunn-Effect (Transferred-Electron) Amplifiers:* The

paper by Monroe describes the effects of package parasitic reactances on the stability and bandwidth of transferred electron amplifiers. Foulds and Lidgey describe a novel mode of amplification in an LSA-type amplifier, using the Gunn effect.

All together, these papers provide a wide coverage of present activity in this field, both in theory and in experimental study of practical amplifiers.

The Editor wishes to thank each of the authors who freely contributed of their time and effort to submit papers for this issue. Thanks are due also to the many individuals who carefully reviewed the papers, some of whom reviewed as many as three or four. They were very helpful, not only to the Editor, but to the authors as well, for their useful and constructive suggestions. Reviewers included the following.

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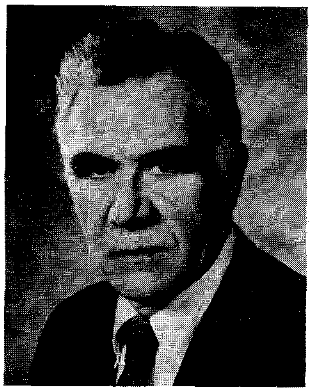
Guest Editor



Marion E. Hines (S'46–A'47–M'50–SM'60–F'68) was born in Bellingham, Wash., on November 30, 1918. He received the B.S. degree in applied physics and the M.S. degree in electrical engineering from the California Institute of Technology, Pasadena, in 1940 and 1946, respectively.

From 1940 to 1945 he served as a Weather Officer with the U.S. Air Force. From 1946 to 1960 he was with Bell Laboratories, where he worked in research and development of microwave and storage tubes, parametric amplifiers, pulse transmission systems, and tunnel-diode amplifiers and oscillators. Currently he is Vice-President and Technical Director at Microwave Associates, Inc., Burlington, Mass., where he has been active in the development of harmonic-generator-type microwave sources, higher power microwave signal-control devices using diode switch elements, and solid-state microwave oscillators and amplifiers.