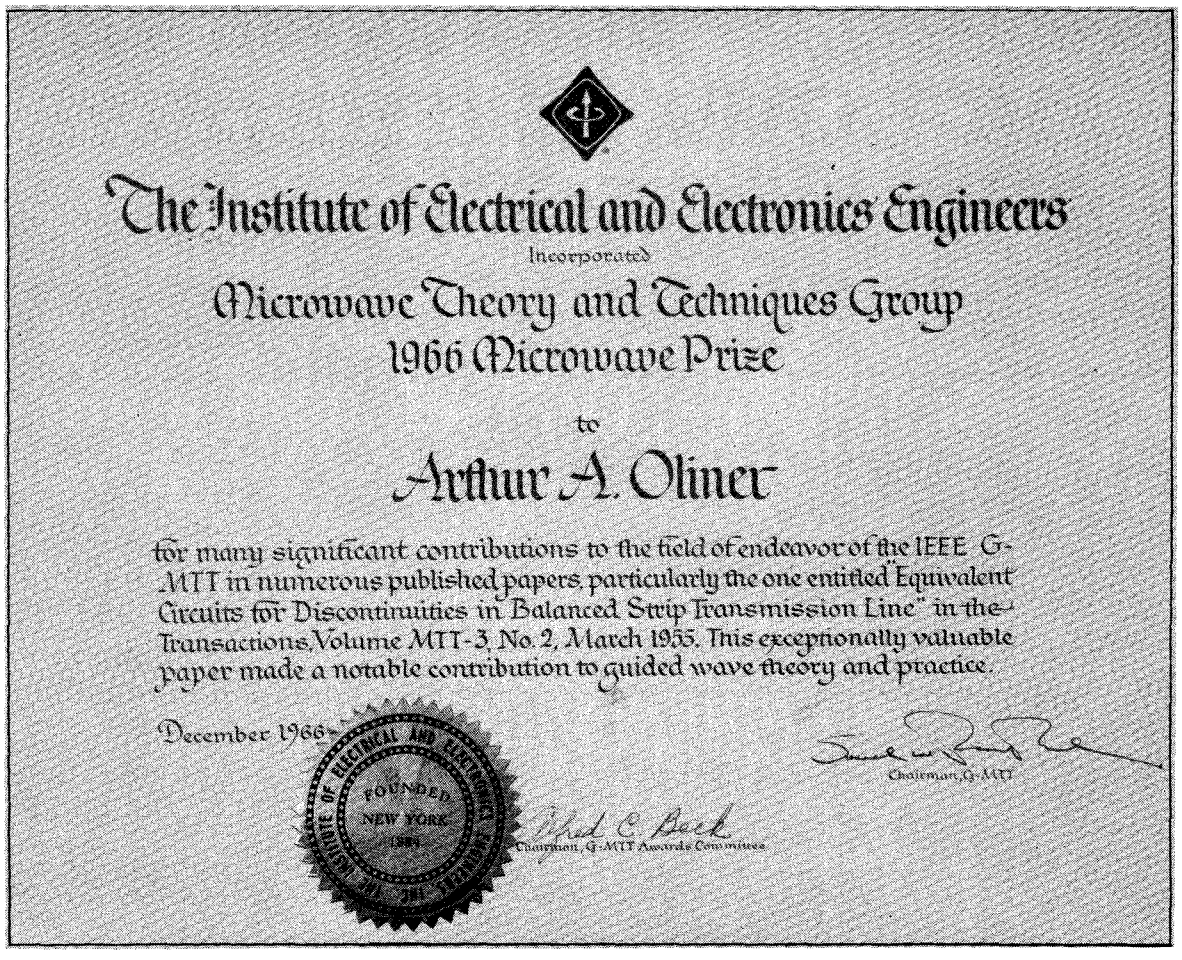
The Institute of Electrical and Electronics Engineers
Incorporated
Microwave Theory and Techniques Group
1966 Microwave Prize
to
Arthur A. Oliner
for many significant contributions to the field of endeavor of the IEEE G-MTT in numerous published papers, particularly the one entitled "Equivalent Circuits for Discontinuities in Balanced Strip Transmission Line" in the Transactions, Volume MTT-3, No. 2, March 1955. This exceptionally valuable paper made a notable contribution to guided wave theory and practice.
December 1966
Chairman, G-MTT
Chairman, G-MTT Awards Committee

# 1967 International Microwave Symposium

THE INTERNATIONAL Microwave Symposium was held in Boston from May 8–11, 1967, with the record-breaking number of 794 registrants in attendance. This number indicated that interest in microwave theory and techniques is still growing. Perhaps the best explanation can be found in the Keynote Address of Prof. A. A. Oliner, Head of the Electrophysics Department of the Polytechnic Institute of Brooklyn.

Prof. A. A. Oliner reviewed the various current fields of interest such as solid-state phenomena, microminiaturization, integrated circuits and increased interest in the higher frequency ranges. In effect, old challenges have been met and conquered, but new ones are constantly being created. One may consider this situation as the existence of a "Technical Medusa."

Two basic types of challenges were commented upon.

1) New applications involving new configurations or different frequency ranges. One must be able to recognize the waveguide character of the geometry or of the phenomenon.

2) Interactions with other physical wave types. Such interactions are encountered in warm gaseous plasmas and in many solid-state effects. Examples used to illustrate these challenges involved size considerations ranging over many orders of magnitude. Earth-ionospheric parallel plate wave propagation so large in scope that 10 Hz can be a frequency of resonant phenomena was considered in the same breath as optical fibers in which the diameters approximate an optical wavelength. For the second case, parametric effects in nonlinear optics and microwave acoustics were considered. It was stressed that most of the theoretical studies in these areas involved unbounded media but that eventually thin films or other restricted forms of construction will be employed to replace the initial bulk concepts. When this takes place, the circuit dimensions will again be comparable to a wavelength. Hence, microwave theory as we know it today, will continue to be called upon as a diagnostic approach.

Thus the stage was set and the performance was started.

There were a total of ten sessions, eight formal daytime sessions and two informal evening sessions. The subjects covered included waveguides, filters and couplers, ferrite devices and associated phenomena, integrated circuits, solid-state sources, control devices, and microwave delay lines.

### Waveguides

The theory of waveguide couplers and power splitters by use of resistive films was described by Prof. G. Epprecht. Advantages of this approach quickly became evident when performance was compared against more conventional techniques.

A relatively new technique for realization of UHF anechoic chambers was described by Prof. K. Suetake which relied on the use of thin ferrite plates. Performance to date was described and results were impressive.

Also presented were papers on computer solution of waveguide discontinuities, millimeter research in Japan, and oversized rectangular waveguide components.

By noontime of the first day, a relatively simple topic area was transformed into a series of presentations disclosing new approaches to both old and new problems that could revitalize even the most ardent skeptic.

### Filters and Couplers

Starting off this session was a discussion on the microwave superconducting resonator by H. Zimmer. E. G. Crystal presented a paper on transmission-line networks. Also presented for the first time was a paper by D. Varon on radial coaxial filters that has at last cleared away the confusion in this area. R. J. Wenzel presented a paper on a new approach to the realization of precision performance diplexers. This was followed with the description of a 720 to 1 microwave compression filter by H. S. Hewitt.

Concluding this session was a series of three papers on power dividers and couplers. These presented new basic designs and concepts along with performance data that once again proved much remains to be done.

### Informal Sessions

On May 8, two informal sessions were held. These dealt with Microwave Integrated Circuits and Microwave Solid-State Sources. These were chaired by R. Webster and F. Sterzer, respectively. Whereas the former was tutorial in nature, the latter was primarily concerned with a discussion on the latest state of the art performance. Both proved to be of high interest and only one fault could be found; the degree of attendance was vastly underestimated and there was standing room only. Comparison of performance and results was the theme and what could and could not be done soon became evident.

### Ferrite Components

Here too, the session started off with a radically new device termed a nonreciprocal ferrite hybrid by M. Omori. It duplicates all essential characteristics of a 3 dB hybrid (coupler) using principles similar to those associated with the junction circulator. Following this was a paper presented by Y. Konishi on a high-power UHF coax circulator. This form of high-power circulator design is becoming increasingly popular as a result of system demands. Comments on the heat transfer aspects were of particular interest to those in the field.

Also presented were a series of papers on switching circulators, along with several presentations on phase shifters for use in various antenna array applications.

### Propagation in Ferrite Media

Here, basic performance was covered by a variety of presentations. These dealt with, among other things, spin-wave considerations, peak power aspects, and computer analysis techniques. Upon completion of this session, one could not help but grasp the magnitude of exploration work that remains to be done. From these papers, the basis of next year's device presentations will undoubtedly be made.

### Integrated Circuits

Probably the largest single area of interest for those attending was in the field of microwave integrated circuits. This session was started off by papers describing basic microstrip transmission characteristics on high dielectric substrates. Presentations made by G. D. Vendelin, K. C. Wolters and P. L. Clar dealt with such parameters as loss, phase shift, and geometrical relationship to line impedance. The information presented will in all probability serve as "working tools" to those in the field for a lengthy period of time.

Following this were presentations on such items as amplifiers, couplers, mixers, and many others.

Perhaps one of the most interesting presentations was a paper dealing with the design and performance of a thin-film harmonic generator by J. B. Horton. The efficient performance achieved at *X* band and the resultant size reduction obtained were of particular significance.

Concluding this session was a timely presentation on a computer analysis approach to integrated circuits by H. E. Stinehelfer which indicated the direction of future efforts in the field and illustrated a method whereby an art can be reduced to a science.

### Solid-State Sources

In addition to varactor multipliers, papers on generation of microwave power by means of diode avalanching techniques were presented. Though both topic areas have been around for some time, advances in performance are continuously being made.

Use of stacked varactors (series connected) in a single package to achieve high-power output at *X* band was described by W. Jann. In addition to this, present-day high-power multiplier performance at 47 GHz was reported on by D. H. Steinbrecher. This was secured through use of design techniques employing iterative synthesis. Both papers illustrated state of the art performance.

In the bulk semiconductor area, recent advances in Japan were thoroughly reviewed by T. Okoshi. The present status of avalanche diode performance was reviewed by B. C. DeLoach along with estimates regarding their future use.

In addition to these two main topic areas, design and performance of a YIG-tuned *L*-band transistor oscillator was covered along with frequency modulation of avalanche transit time oscillators. Concluding this session was a presen-

tation on high-speed binary pulse regeneration at microwave frequencies as utilized in PCM systems.

The session helped to explain why so much effort has been expended in this area. The utilization of solid-state microwave sources in operational systems has been with us for some time now but its full potential has yet to be realized.

### Microwave Control Devices

The session on microwave control devices dealt mainly with performance of components that had been developed and tested, although some theoretical aspects were also covered. A linear phase modulator scheme employing varactor diodes and careful circuit design was covered by R. V. Garver.

This particular presentation was of great interest since it represents a building block concept vital to many modulation techniques. Most previous diode phase modulators left a great deal to be desired with regard to linear performance.

Following this were papers on diode pulse modulators, wideband high-power switches, and one dealing with high-power limiting by use of *PIN* diodes. This was presented by N. Brown and showed how high-power diode limiting devices could either replace or supplement conventional gaseous duplexers with resulting overall advantages.

Other topics covered were ferroelectric phase shifters and a gaseous equivalent of the varactor phase shifter capable of handling high-power at *X* band. Concluding this session was a presentation by H. Goldie that described a technique for generation of high-power narrow bandwidth microwave pulses in the order of 10 ns. This was accomplished by using thyratron microwave switches mounted in a waveguide.

### Microwave Delay Lines

The final session on microwave delay lines caused a late surge in symposium registration, confirming the recent widespread interest in this area due to the potential "pay off" in system performance. The first paper by E. A. Ash, dealt with a theoretical review of acoustic surface waves and experimental results obtained at 1 MHz that can hopefully be scaled up in frequency. The second, by H. J. Shaw, was a review of appropriate materials utilized in transducers and delay lines. Also discussed were the acoustic–optic properties of these materials as applied to the scattering of light by sound waves. A presentation on broadband *L*- and *S*-band delay lines was made by L. R. Whicker. This included information on improved transducers and coupling circuits.

The final three papers all concentrated on time delay of microwave signals through devices using YIG material. Each was concerned with a different technique for using these delay lines as pulse compression filters in broadband systems.

### The Banquet

The symposium banquet was held on May 9. The attendance was large and the program interesting. The Master of Ceremonies, D. Atchley, set the pace and awards were made to A. A. Oliner and W. W. Mumford. These were the 1966 IEEE G-MTT Microwave Prize and the Morris E. Leeds Awards, respectively. The featured speaker was Prof. J. C. Slater who spoke on his experiences at the Radiation Laboratory over two decades ago. One could not help but be impressed by the results obtained with limited facilities.

ADCOM Chairman Prof. S. W. Rosenthal presents the Microwave Prize Award to Prof. A. A. Oliner (above) and the Morris E. Leeds Award to W. W. Mumford (below).

Prof. Slater described early efforts concerned with establishing the theory of the magnetron and several amusing incidents associated with it. This involved a difficult theoretical discrepancy that contained two self-cancelling mistakes, a fortunate occurrence that few encounter in actual practice.

### Conclusion

The record attendance at "G-MTT 1967 International" confirmed the further expansion of microwave technological areas. The technical papers demonstrated that great strides have been made in the past year and provided a clear picture of how various infant aspects of microwave technology have matured. At the same time, however, they also illustrated the enormity of work that yet remains.