The 1973 G-MTT National Lectureship

Solid-State Reliability

THE CONCEPT of an all solid-state radar was founded upon the premise that such a radar should be inherently more reliable than conventional radars utilizing a transmitter tube and a mechanically scanned antenna. Despite the expenditure of some 50 million in system and transmit–receive module development, the fundamental premise remains unvalidated. An investigation of the fundamental physics and test procedure design that will allow confidence in the prediction of device lifetime is needed.

The lecture reviews the basic concepts of solid-state phased arrays and describes past and present module development. It is pointed out that to date generally two types of modules have been developed. The types include modules for search radar applications which operate in the 1–2-GHz region and modules for airborne fire control radars which operate in the 8–10-GHz region. The modules normally consist of a transistor power amplifier, phase shifter, mixer, and low-noise amplifier. The higher frequency modules, additionally, contain a frequency multiplier. Specific modules described are the MERA, RASSR, MAIR, and CAMEL.

It is pointed out that the microwave power transistor used in the power amplifier represents the largest potential problem from a reliability standpoint. The problem is made more complex by the fact that the state of the art in microwave power transistors is rapidly changing as photolithographic techniques and processing techniques are improved. Further, the problem is complicated by the fact that different transistor suppliers utilize different metallization, different processing techniques, and a device geometry which varies from firm to firm.

It is pointed out that the reliability in microwave power transistors and in turn module reliability must be obtained in two ways. 1) Fairly fundamental device physics studies must be made to eliminate or reduce failure modes in power transistors. 2) Meaningful stress testing techniques must be developed and verified to qualify transistor types. It is felt that these two tasks are interdependent and that stress testing of transistors is meaningful only if results of the testing are correctly interpreted. The cost for making a reliable module and in turn a reliable phased array may double the anticipated initial developmental cost. It is, however, a cost which must be incurred. To date, the Army has made a good start on the transistor reliability for devices used in the CAMEL program. The Navy has initiated a small failure physics program on microwave transistors at the Naval Research Laboratory. These programs are just starts, however, and further efforts are required.

——JOHN L. ALLEN

John L. Allen (S'55–M'57–F'72) was born in Estherville, Iowa, on June 13, 1931. He received the B.S. degree in engineering science from Pennsylvania State University, University Park, in 1958, and the S.M. degree in electrical engineering and the Ph.D. degree in communications biophysics, both from the Massachusetts Institute of Technology, Cambridge, in 1962 and 1968, respectively.

From 1950 to 1954 he was in the U. S. Air Force—spending two years as a student and an Instructor at the Air Force Radar School, and two years at the M.I.T. Lincoln Laboratory. While attending Pennsylvania State University, he was employed as an Engineer by HRB Singer, Inc. After graduating he returned to Lincoln Laboratory as a Staff Member and advanced to the position of Associate Head of the Radar Measurement Division. He joined the Research Department of the Naval Research Laboratory, Washington, D. C., as the Associate Director of Research for Electronics on March 1, 1971.

Dr. Allen is a member of Tau Beta Pi Engineering Honor Society. He has served on several studies and committees for professional societies and for the Department of Defense.