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INVITED: PROGRESS OF MICROWAVE SOLID STATE DEVICES IN JAPAN

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Japan has many of the problems that microwave is best-suited to solve-communications needs of a dense population, a combination of mountainous terrain and narrow streets that make coaxial cable difficult to install, and frequent earthquakes. Today Japan has the densest microwave system in the world. Yet the nation demands more advanced communications services in quantity and quality. And many other nations demand reliable, economical and advanced Japanese microwave communications systems for fulfilling the needs of their nations. Japan has manufactured more microwave communications equipments for other nations than for her own.

This particular environment of Japan has stimulated the progress of microwave solid state devices. This is considerably different from many other nations where military needs have had major impacts on the development of microwave solid state devices. Japan's first solid state 11 GHz system went into operation in 1962. Since then 2, 4, 6, 7, 12 and 15 GHz systems have been developed and 20GHz and millimeter wave systems for circular wave waveguide and satellite communications are under development. Besides communication applications, rader and other civil applications also demand improved microwave solid state devices.

This paper reviews the present states of microwave solid state devices in practical systems and of current development of improved devices in Japan. These will include microwave bipolar transistors, FET, Gunn and IMPATT diodes, varactors, mixer diodes, transfered electron amplifier and functional devices, and ferrite devices. The performance is emphasized in higher frequency limit, output power, efficiency and noise. Microwave integrated circuits using these devices are presented together with monolithic IC for high speed logics. For practical applications, the reliability of microwave devices is largely related to thermal stresses. The thermal problem is discussed together with the package and interconnecting circuit problems. The progress of microwave solid state devices owes largely on the progress of material and process techrology, which are discussed wherever needed. Finally, problems are discussed for furthering the progress of microwave solid state devices.