V-1. SURVEY OF INTEGRATED CIRCUITS WITH IMPLICATIONS FOR MICROWAVES

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There are two major, or classical, categories of integrated circuits based on the techniques employed: film circuits and semiconductor monolithic circuits. With the film technique one or more elements and/or components are deposited by one of several methods on a passive substrate, e.g., glass or ceramic, to form resistors, capacitors and electrical interconnections. Active elements, i.e., transistors and diodes, must be affixed separately to metallic connectors on the substrate. In the semiconductor monolithic approach the entire circuit containing resistors, capacitors, diodes and transistors is fabricated within a solid block of semiconductor material by using selected diffusion techniques. The advantage of the monolithic circuit, that of having all of the circuit elements as an integral part of the structure, is offset to some extent by the somewhat poorer characteristics of the resistors and capacitors relative to their film counterparts. Both types of integrated circuits have been used in a variety of applications, both digital and analog. Film circuits generally have been developed for specific needs by systems manufacturers, whereas monolithic circuits have been made available by a number of semiconductor device manufacturers throughout the world.

Monolithic circuits have been applied most widely in the digital field. The primary reason for using integrated circuits in electronic systems thus far has been decreased cost and increased reliability, with small size as a secondary factor in general. Improved performance, by and large, has not been a major reason for using integrated circuits.

Most of the current commercial integrated circuits have been, until very recently, simple translations of discrete component circuits into integrated form. More recently, however, with third and fourth-generation integrated circuits, particularly in the analog field, circuit designers have begun to innovate and to design circuits which are based on inherent characteristics of integrated circuit construction. In such cases, the circuit performance on a functional basis frequently is superior to a circuit which was designed with discrete components to provide the same functional result. The approach taken in such cases, however, may be quite different from the classical discrete components approach, e.g., large numbers of transistors and diodes are used to eliminate the need for large value resistors. Application of integrated circuits to microwaves generally has been re

Application of integrated circuits to microwaves generally has been relatively slow. For one reason, direct translations of microwave circuits into integrated form generally do not yield satisfactory performance. Hence, the integrated microwave circuit designer requires a high degree of innovation of the type referred to above. In addition, some of the approaches require advances and research in semiconductor material technology. At the same time, however, some of the advantages of miniaturization inherent in integrated-circuit techniques are a natural ingredient for microwave integrated circuits.

The penetration of integrated electronics into the microwave field depends, in the last analysis, on the performance of solid state devices at microwave frequencies. This already has been established with high-frequency performance of semiconductor devices improving year by year at an impressive rate, hence the future for integrated microwave circuits looks bright indeed.