V-4. INTEGRATED MICROWAVE CONTROL DEVICES

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Microwave integrated circuits are quickly becoming a reality. The initial results of this work are similar to the path followed by low frequency conventional microelectronics, that is, the first emerging of useable hybrid integrated circuits followed by monolithic circuits. Hybrid, in the case of microwave circuit, refers to the use of chips of silicon containing the active devices mounted in a microwave cavity or stripline with ceramic or an equivalent material used as the dielectric.

An advantage of using alumina for the dielectric is its high dielectric constant which reduces the size of circuits where 1/4 wavelengths are necessary for design reasons. Also, alumina is dimensionally stable, has low loss, and withstands high processing temperatures.

A general technology has been developed that enables the fabrication of microwave hybrid circuits in ceramic microstrip line in a short duration of time. It is necessary in circuit development work to be able to make adjustment and design changes without a long cycle of mask making and circuit preparation. The process consists of depositing a plastic film on ceramic, cutting out of a pattern in the film, depositing a conductive material over entire surface, then removing the remaining film (mask) leaving the defined circuit. The circuit is then fired at 900°C to sinter the silver metal layer into the ceramic. This metal layer has excellent mechanical and electrical properties, and allows welding or soldering of components.

Two circuits fabricated by this process are shown in Figs. 1 and 2. Figure 1 is a SPDT L-band switch with shunt mounted glassed PIN diodes; Fig. 2 is a SP3T series switch (4 diodes in each arm), complete with dc-blocking capacitors and bias leads. The active elements used in the SPDT switch are glass passivated PIN diodes capable of switching kilowatts of power at MH_z rates. The SP3T series switch is a high isolation, 3 GH_z low power device employing thin base small area PINs. Detailed electrical results on both designs will be presented.

The glassed PIN diode is constructed with transition plates on each side for maximum heat capacity capability and minimum thermal resistances. The glassed construction is shown in Fig. 3. The passivating glass material is a high temperature glass specifically used for its stability resulting

from elimination of migration of impurities under high fields and high temperature. Also, the high dielectric constant of the glass eliminates arcing at high voltages. The series diodes are fabricated from epitaxial material grown to obtain high resistivity. The thin base width is necessary for switching speed requirements.

To obtain good electrical performance, care must be exercised in the design of cavity dimensions to prevent spurious modes propagating, in bias lead lengths to prevent resonances, in line connections to prevent extra capacitances and in the transition reflections contributed by the ceramic microstrip line to conventional coax line connection. The two circuits discussed are representative of the problems encountered in microstrip line hybrid integrated control devices using a high dielectric constant dielectric.

In circuits where 1/4 wavelengths are not a basic part of the design, such as in switches and limiters designed as filter structures, air dielectric is useable. In Fig. 4 is shown a 20-watt broadband limiter with less than 0.7 db insertion loss and 30 db isolation thru C-band. This structure consists of two small capacitance limiter-type varactors.

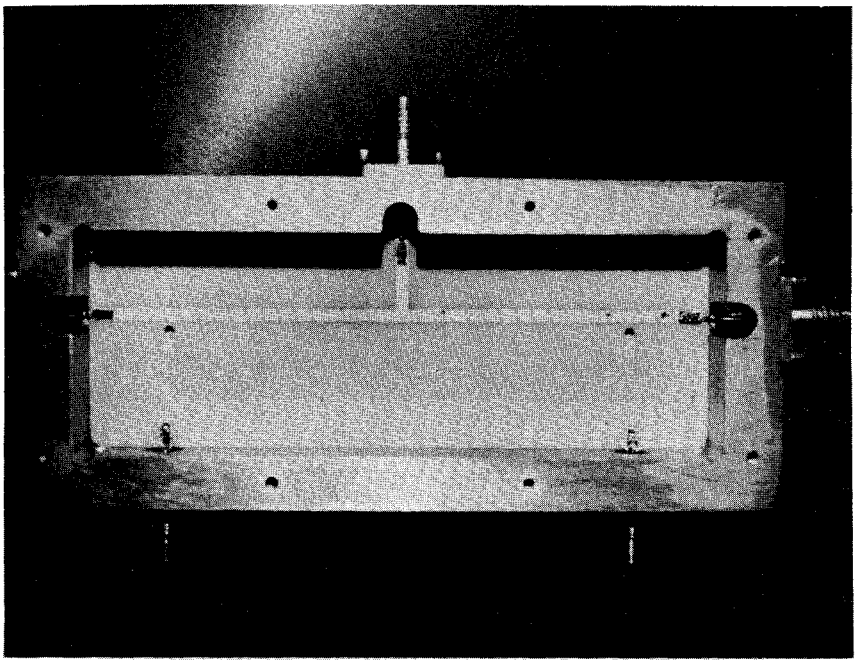

FIGURE 1. SPDT HYBRID L-BAND AIMS SWITCH (SHUNT MOUNTED DIODES)

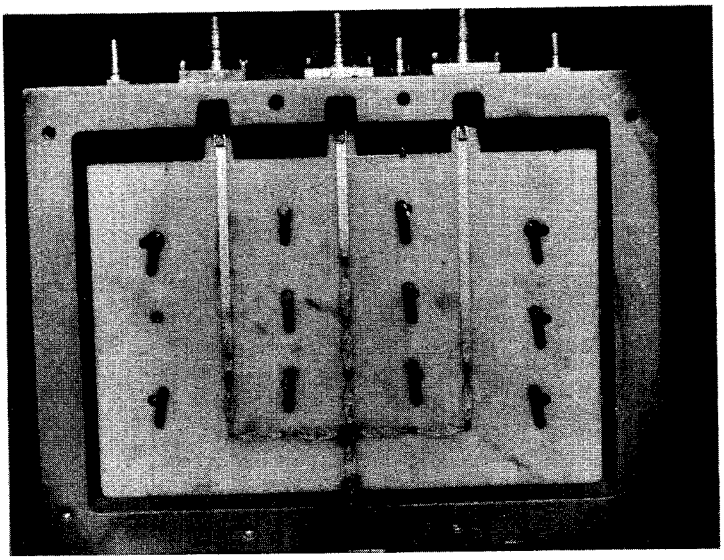

FIGURE 2. SP3T HYBRID S-BAND SWITCH (SERIES MOUNTED DIODES)

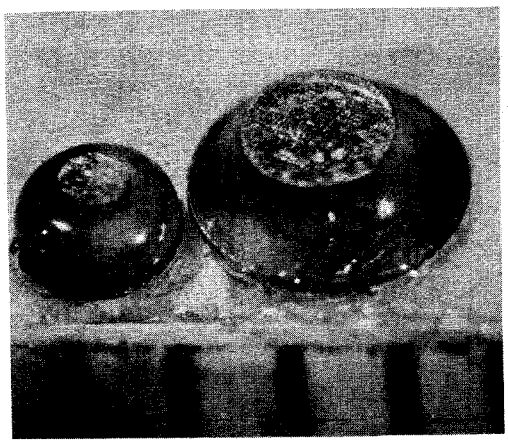

FIGURE 3. GLASSED MESA PIN ELEMENTS (WITH MM SCALE)

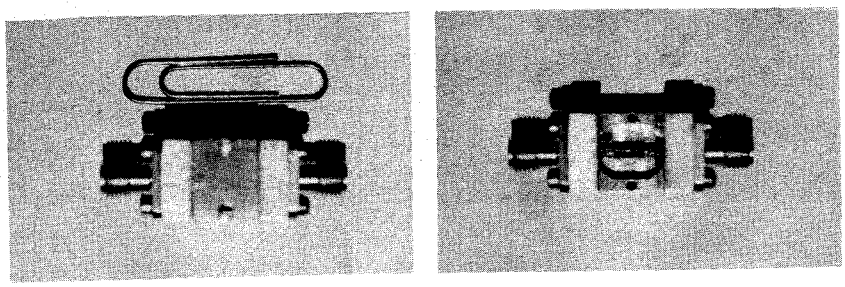

FIGURE 4. BROADBAND INTEGRATED LIMITER