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A Flexible CPW Package for a 30 GHz MMIC Amplifier

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A FLEXIBLE CPW PACKAGE FOR A 30 GHz MMIC AMPLIFIER

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SUMMARY

A novel package, which consists of a carrier and housing, has been developed for monolithic-millimeter wave Integrated Circuit amplifiers which operate at 30 GHz. The carrier has coplanar waveguide (CPW) interconnects and provides heat-sinking, tuning, and cascading capabilities. The housing provides electrical isolation, mechanical protection, and a feed-thru for biasing.

INTRODUCTION

MMICs (monolithic-millimeter integrated circuits) are currently available for satellite communication applications at millimeter wave frequencies (ref. 1). However, very little has been done in the development of carriers and housings that enable these circuits to be inserted into actual systems. In this paper we present the design and characteristics of a CPW (coplanar waveguide) carrier and a housing for MMIC amplifiers operating at 30 GHz. CPW circuits have the advantage of providing easy series as well as shunt mounting of microwave devices. Furthermore, since the ground planes are on the same side as the strip conductor, via holes and wraparounds are eliminated; therefore, parasitics are small. Radiation loss, when compared to microstrip, is low; hence CPW circuits are less prone to interaction with the package and EM interference. Another advantage is that CPW circuits lend themselves to fast and inexpensive characterization using wafer probing equipment.

CARRIER DESIGN

The carrier assembly is shown in figure 1. The carrier consists of a finite width conductor backed CPW (CBCPW) circuit on a dielectric substrate. The CBCPW circuit consists of a pair of tapered open circuits which face each other, and are separated by the surrounding ground plane. The ground plane also serves as an island for mounting MMIC devices and facilitates low inductance ground connections from any point on the perimeter of the MMIC. The length of separation between the open circuits is chosen to accommodate a particular MMIC chip. By tapering the CPW open circuit the electric field lines are concentrated at the open end and therefore are coupled efficiently to the short wire bonds between the CPW input/output lines and the MMIC. A copper post (diameter 0.031 in.) inserted in the center of the carrier serves as a heat sink for the MMIC. A brass backing plate provides heat dissipation and mechanical support. The MMIC and brass backing plate are attached to the dielectric substrate using silver conductive epoxy.

This carrier provides advantages in the following areas: Tuning, cascading and calibration. MMIC tuning is accomplished by sliding small lengths of metal strips over the CPW circuit until the desired S-parameters are obtained. The metal strips are then glued in place. Two or more of the above carriers can be cascaded, as shown in figure 1, by use of a novel plastic clip. The clip slides over and grips the two brass backing plates. This ensures excellent alignment for wire bonding. LRL calibration can be performed to the plane of the MMIC.

HOUSING

A single carrier with the housing is shown in figure 2. The housing provides mechanical protection, electrical isolation, and a coaxial feed-thru for bias lines.

EXPERIMENTAL RESULTS

A single carrier was tested by fixing a 50 Ω GaAs microstrip line, 700 mils long, in place of an MMIC, wire-bonding it to the CPW lines and measuring the S-parameters over the frequency range of 29 to 30 GHz with an HP 8510B Network Analyzer. The measured insertion loss, $S_{21} = 1.9$ dB and the return loss, $S_{11} < -15$ dB, as shown in figure 3. This includes the losses of the Wiltron Universal Test Fixture and the carrier. These losses were found to be 0.9 dB by measuring the insertion loss of an identical CPW thru-line on an identical substrate. The insertion loss and return loss measured with and without the housing is shown in figure 4. The S_{21} measured, without the microstrip line, is a measure of the isolation between the input and output ports. The carrier and the housing were tested. An isolation of greater than 16 dB was measured, which is an improvement of 10 dB over the isolation of the carrier without the housing. The measured characteristics are shown in figure 5. Figure 6 shows the carrier, carrier with housing and cascaded carriers.

REFERENCE

1. Saunier, P.; and Tserng, H.Q.: AlGaAs/InGaAs Heterostructures with Doped Channels for Discrete Devices and Monolithic Amplifiers. IEEE Trans. Electron Devices, vol. 36, Oct. 1989, pp. 2231-2235.

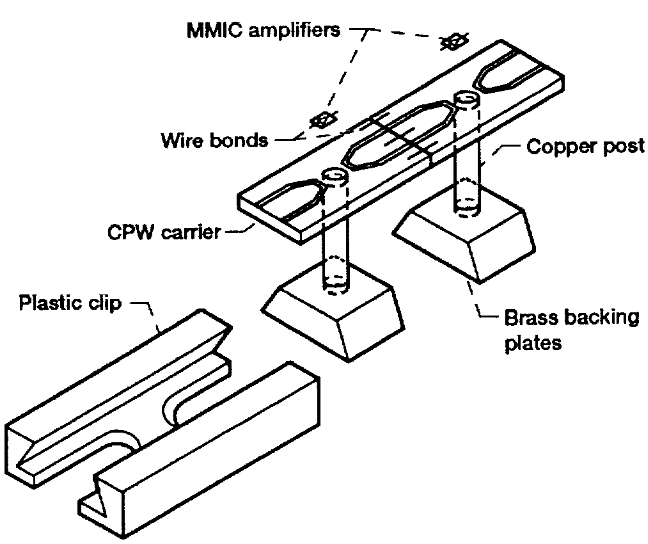


Figure 1.—Schematic for cascading CBCPW carriers using a plastic clip.

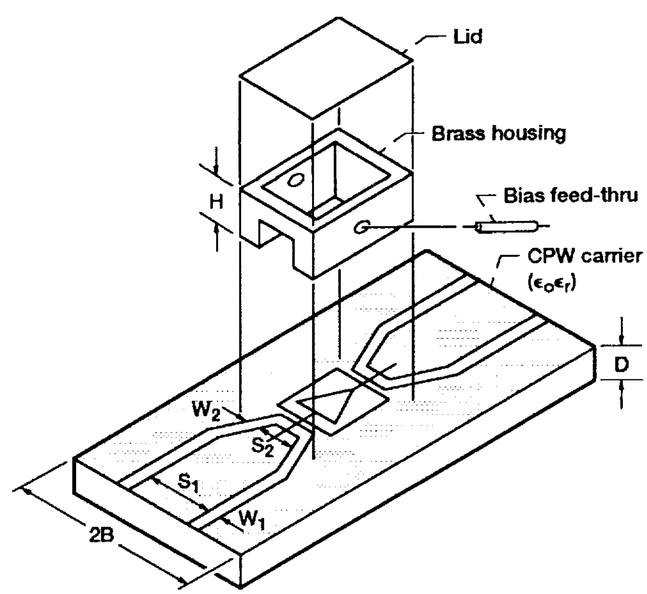
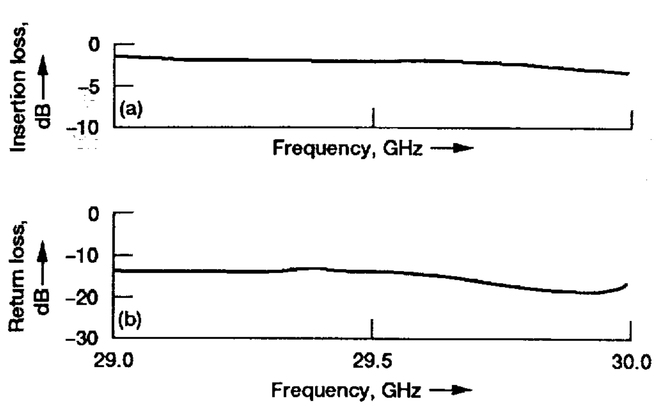
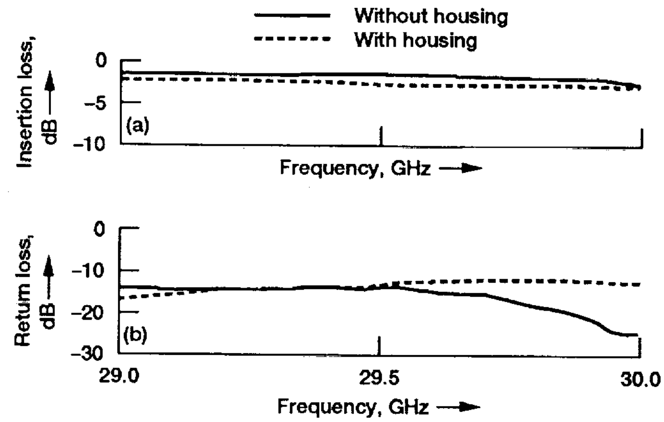


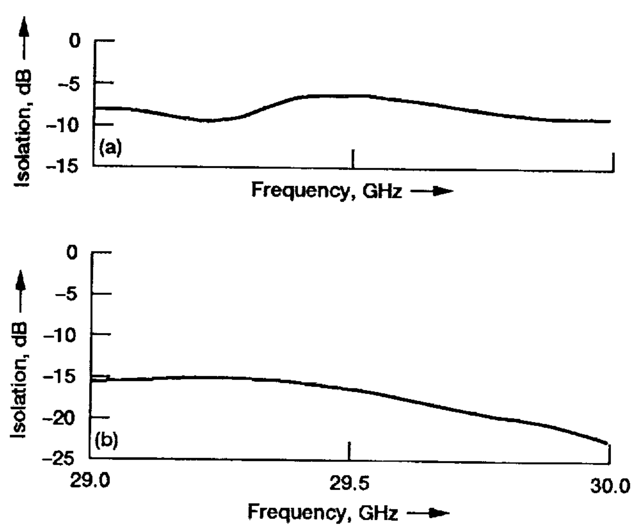
Figure 2.—Schematic of carrier with housing. Finite width conductor backed coplanar waveguide; S_1 = 0.013 in., W_1 = 0.010 in., S_2 = 0.010 in., W_2 = 0.008 in., D = 0.025 in., ϵ_r = 10.5, 2B = 0.2 in., H = 0.135 in.



(a) Insertion loss.
(b) Return loss.
Figure 3.—Measured characteristics of the carrier.



(a) Insertion loss.
(b) Return loss.
Figure 4.—Effect of housing on the measured characteristics of the carrier.



(a) Without housing.
(b) With housing.
Figure 5.—Measured isolation.

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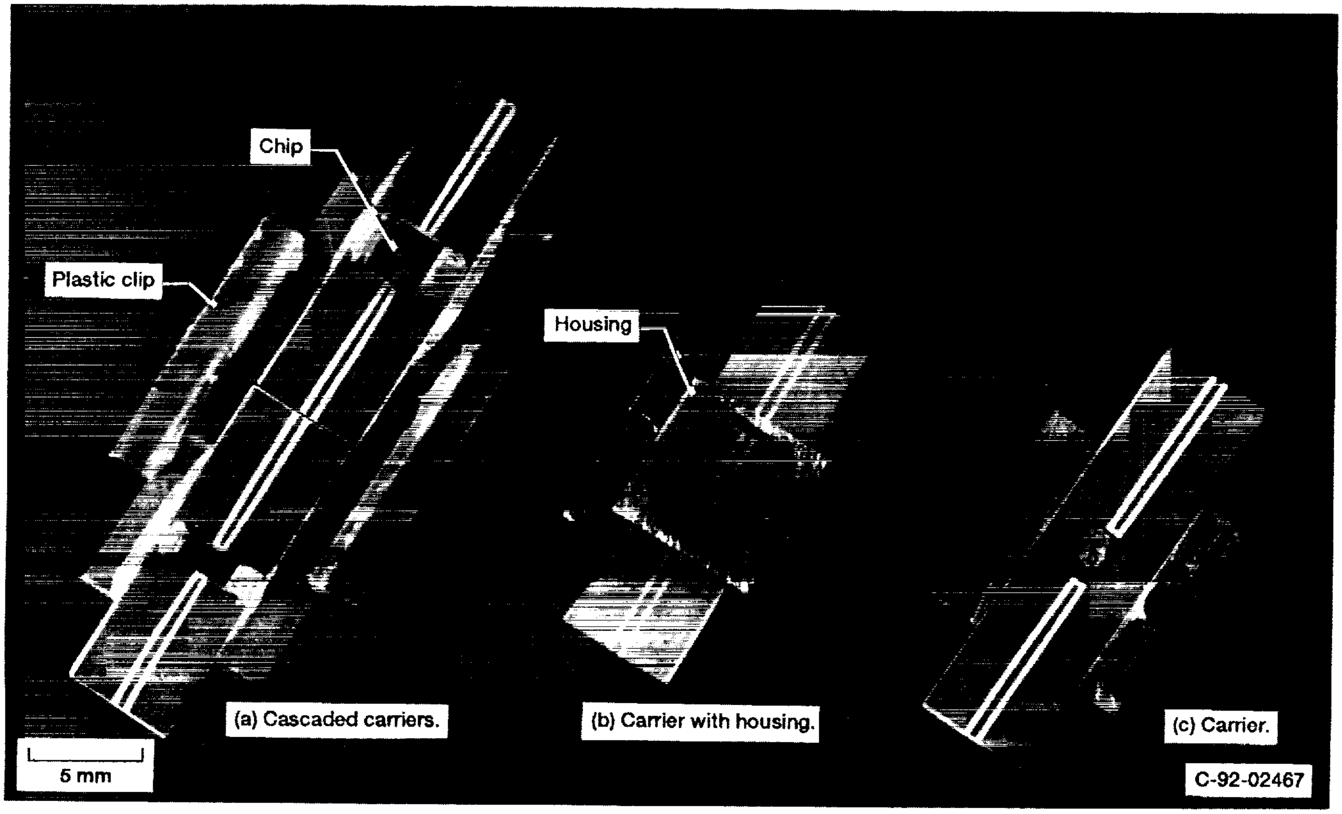

Figure 6.—CPW carriers.

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13. ABSTRACT ***(Maximum 200 words)***

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