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Radar Transmitter and Receiver MCM Subassemblies Implemented in LTCC

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Abstract

The development of transmitter and receiver Multichip Module subassemblies implemented in LTCC for an S-band radar application followed an approach that reduces the number of discrete devices and increases reliability. The LTCC MCM incorporates custom GaAs RF integrated circuits in faraday cavities, novel methods of reducing line resistance and enhancing lumped element Q, and a thick film back plane which attaches to a heat sink. The incorporation of PIN diodes on the receiver and a 50W power amplifier on the transmitter required methods for removing heat beyond what thermal vias can accomplish. The die is a high voltage pHEMT GaAs power amplifier RFIC chip that measures 6.5 mm x 8 mm. Although thermal vias are adequate in certain cases, the thermal solution includes heat spreaders and thermally conductive backplates. Processing hierarchy, including gold-tin die attach and various use of polymeric attachment, must allow rework on these prototypical devices. LTCC cavity covers employ metallic coatings on their exterior surfaces. The processing of the LTCC and its effect on the function of the transmitter and receiver circuits is included.

Key Words: LTCC, RF, MCM, transmitter, receiver

1. Introduction

LTCC is an enabling technology for microwave subsystems due to the low resistance and good resolution of its conductors, uniformity of dielectric layers, and low losses. Lower loss dielectric systems exist, but conventional LTCC is more than adequate for S-band radars. A transmitter and receiver MCM have been fabricated in the gold-based LTCC, using 13 layers of tape and providing faraday cavity isolation. An approach to improve reliability has been to incorporate additional functions into RFICs, eliminating the need for large numbers of discrete devices and the solder joints that accompany them. This leads to an interest in additional embedded components for functions normally provided by discrete components. Individual elements of these MCMs require as much as 150db isolation.

2. Basic Construction

The MCMs are constructed of 13 tape layers, each of which fires to 0.0055" thickness. This provides cavities for components and sub-elements of the radar. Faraday enclosures are accomplished by a combination of double-row via fences, solid and cross-hatched regions of ground planes, and metallized lids which are attached with conductive materials. Processing considerations include out of plane extrusion or 'posting-up' of vias, solderability and wirebondability of thick films, and reworkability.

3. Receiver

A critical portion of the design involves heat removal from PIN diodes in the upper left cavity. This is accomplished by the use of a pedestal in the CuW heatsink/backplate. The interconnect is accomplished with gold wirebonds with attention to loop heights. Isolation is accomplished by a combination of meshed ground planes and via fences. Processing challenges include maintaining the planarity of critical surfaces with dense via arrays.

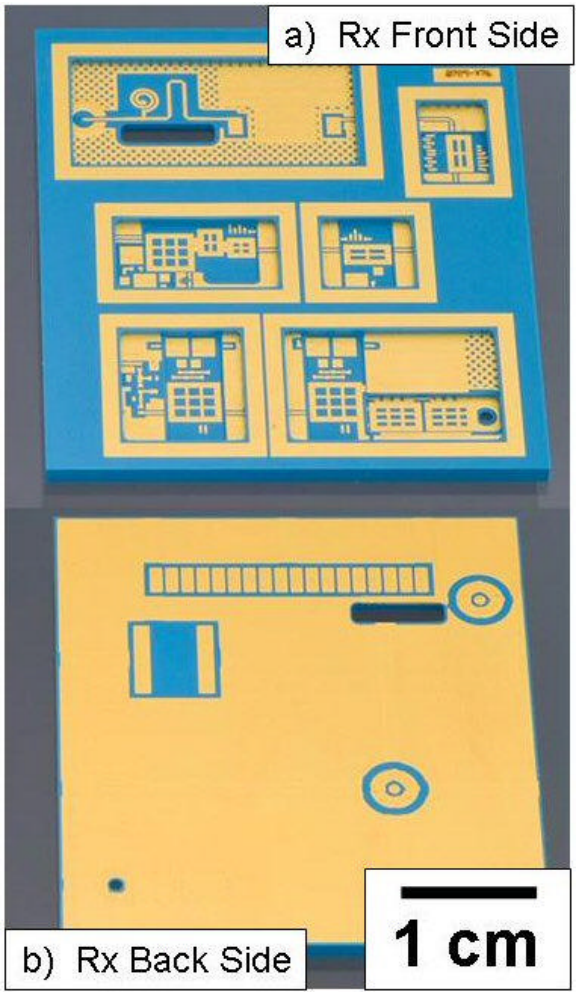

Figure 1. Receiver MCM: a) Front side features include seal rings and multilevel cavities and through-holes for heat sinks and connectors. b) Back side supports a few discrete devices and connectors.

Transmitter

The transmitter MCM was also a multi-cavity device employing microstrip connections between cavities. The transmitter includes a 50W power amplifier. The opening in the MCM permits the direct attachment of a heat spreader to the backplate. Heat spreaders of Cu-W and diamond composite material are under evaluation. Transmitters currently being tested employ a thick film backplane. A thin film back plane is envisioned for transmitters in process. An image of the transmitter circuit is shown in Figure 2.

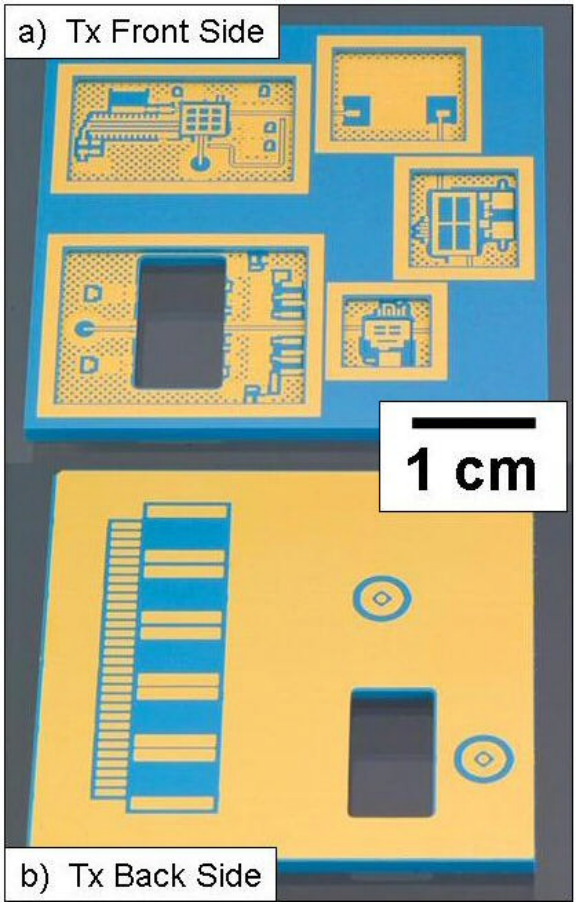

Figure 2. Transmitter MCM: a) Front side features include seal rings and multilevel cavities and through-holes. b) Back side supports a few discrete devices and connectors.

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