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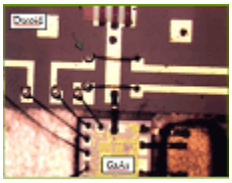
Microwave Packaging Technology

Microwave modules, hybrids, MICs (microwave integrated circuits), RF MMIC (monolithic microwave integrated circuits) modules, all require a unique set of materials and processes necessary to achieve reliable operations in extreme military, aerospace and commercial environments. Microwave packaging technology in the context of this article it refers to relatively small packages (smaller than the outline of your cell phone) hermetically sealed or "nearly" hermetically sealed chip and wire modules. Proper spacing of MICs interconnected with other passive components inside a ceramic or metal can to achieve a specific RF function is an art form that takes years to master. Here are a few things to keep in mind when assembling a microwave module.

Design for manufacturability (DFM) is a critical concept in the early phase of microwave design. A poor design results in yield loss, production delays, reliability problems and unhappy customers. Microwave hybrid circuit designers must "design with the process in mind". Any circuit that can't be assembled within reasonable cost and schedule constraints is a bust. DFM requires designers to perform detailed computer stress and thermal modeling analysis up front before ever committing to production. Finite element analysis (FEA) identifies weakness in the mechanical design and guides the selection of materials based on the package geometry and coefficient of thermal expansion for each candidate material. Thermal modeling is another critical DFM requirement. Heat build up inside a microwave power module is the number one cause of early field failures. Based on the thermal analysis model designers can select the proper heat spreaders to keep the junction temperatures below specification and assure reliable operation.



Microwave modules are manufactured with a unique set of materials and processes. Substrates made from copper clad Teflon are often used because of their desirable dielectric constant, low loss tangent and other RF properties. However, the teflon "soft board" material creates problems in die attach and wirebond. When the ultrasonic energy from a wirebonder hits the soft substrate the energy is dissipated and this effectively shrinks the bond window and leads to a lot of frustration during assembly. Gold tin (AuSn) eutectic die attach of gold back MMICs is a very common process in power modules. MMICs are made from very thin (.004 " and less) gallium arsenide material, which has about one half the fracture toughness of silicon. These fragile chips have to be carefully handled and soldered down to obtain a complete void free interface to the substrate, or risk hot spots and stress build up on the die surface. Deep access wire and ribbon bonding often follow after die attach. This is another critical process step far beyond the scope of this article.

After assembly the next step is to hermetically seal the unit to protect moisture from entering the package. Laser welding aluminum alloys or seam sealing iron-nickel alloys is the preferred method to create a hermetic seal. What is hermeticity? The dictionary definition of the term "hermetic" means a seal that is gas tight or impervious to gas flow. In the context of a hermetically sealed microwave module it implies an airtight seal that will keep moisture and other

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harmful gases from penetrating the sealed package. Of course it also means that it keeps hydrogen and other gases from escaping, which can lead to a problem known as “hydrogen poisoning”. MIL-STD-883 Test Method 1014 is the universally accepted test designed to determine the effectiveness or hermeticity of the seal. Lately, microwave companies are turning to plastics and other materials such as Liquid Crystal Polymers (LCP) to make the package.
When the term “near -hermetic” or “non-hermetic” packaging is used it implies the package is made from polymeric materials as opposed to glasses, metals and ceramics. Non hermetic parts made from plastics reduce cost, weight, size and if designed, manufactured and tested properly hold the promise of a reliable substitute for a hermetic can. But a “non” or “near-hermetic” package simply put is not hermetic as defined by the military specs.

In summary, there are many technical details that must be reviewed in order to successfully design, assemble and seal a microwave module. It begins with a careful design and focus on manufacturability. Assembly processes such as substrate fabrication, die attach and wirebond present their own set of problems unique to devices that operate at microwave frequencies and above. Finally, the decision to hermetically seal the device should be based on the susceptibility of the device types to moisture, the expected end use environment and lifetime of the product.