Alternative to SMT for microwave and millimeter-wave systems

By Javed Siddiqui, Dan Sundberg and Dominick Suarez

When faced with the challenge of reducing the size and improving the manufacturing efficiency of complex microwave and millimeter-wave systems, engineers will often turn to surface-mount technology (SMT). Conventional SMT works well for frequencies up to about 6 GHz. However, at higher frequencies SMT is usually not a viable option because in SMT topology the transmission lines are unshielded, and the components do not have adequate grounding. This results in unwanted radiation, coupling and regeneration.

Another problem with RF SMT systems is the lack of an easy way to characterize the performance of the individual microwave components. With traditional connectorized components you can easily connect them to the ports of your test equipment and get an accurate characterization. With SMT components, you would need to either find, or more likely, design and fabricate a suitable test fixture that will allow the device to be connected to the ports of the test equipment. And, the test results are often inaccurate due to the differences in the launch conditions and related parasitic losses of the device when measured in the test fixture as compared to when the device is mounted to the SMT board.

For these reasons, reducing the size and increasing the level of integration of microwave and millimeter-wave systems requires an alternate approach. By using unique device packaging, and an innovative approach for cascading the devices, these high-frequency systems can be assembled with predictable results. And, an added benefit is a significant reduction in frequency response ripple without the need for isolators between the individual components. This is due to the reduction of the electrical length between the microwave components.

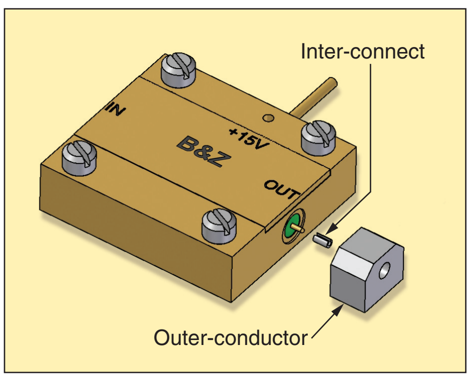

Figure 1. The interconnect and the outer conductor of the Ultra Package.

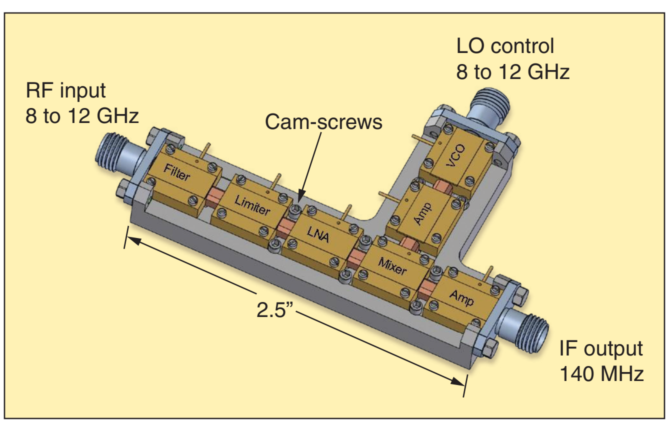

Figure 2. With the Ultra Package, a completely assembled millimeter-wave downconverter is only 2.5 inches long. It exhibits excellent isolation and small size at millimeter-wave frequencies.

Desirable characteristics of the individual component packages require a package that is small in size, and can operate at frequencies up to 70 GHz and that can be connectorized for easy device characterization. Also, it should be able to be placed in a component chain in a way that reduces the possibility for RF leakage that could lead to regeneration. These desirable characteristics, along with the need for good thermal dissipation, component mounting, RF grounding, and easy connectorization for device characterization should be considered when designing a package.

One such package is the Ultra Package developed by B&Z Technologies. This package is small, measuring only about 0.4” x 0.4” x 0.1.” It operates well up to 70 GHz. This is due to its small coaxial RF feed-through size with pin diameters of 0.009,” the design of the microwave cavity and the package mounting features. The small feed-throughs minimize the possibility for higher-order mode excitation. The package is easy to connectorize to allow precise device characterization. Also, the microwave cavity is designed to reduce any waveguide effect. And finally, the cavity is configured in a way to allow efficient launching to 0.1 mm thick discrete devices. Most high-frequency discrete devices and MMICs are 0.1 mm thick. These packages work well with available MMICs. These would include VCOs, amplifiers, attenuators, mixers as well as circuits consisting of individual discrete devices.

The technique to cascade this type of package is simple but effective. The obvious first step is to package the microwave component and characterize its performance. Then, starting at one end of the RF chain, the first device is mounted in place. Then, a female-female interconnect (Figure 1) is placed on the RF pin that is to be connected to the next device in the RF chain. Next, the outer conductor block is placed over the RF pin with the interconnect already in place. Finally, the next device is slid into place, making sure its input pin engages the other end of the interconnect that is on the first component (Figure 2). To prevent unwanted radiation, these two cascaded components need to be held under end-end pressure to ensure the outer conductor makes full contact with the component housings. This pressure is maintained with cam-screws. These cam-screws can be easily made from existing commercial hardware by machining the head of a machine screw so that the head is eccentric to the major diameter of the screw threads.

Further units can be cascaded by following the previous steps. The ends of the RF chain can be terminated with various types of interfaces. For example, the ends can be terminated directly with a waveguide without the need for adding a pair of connectors. The RF connections can also be standard 3.5 mm, 2.92 mm or 1.85 mm coaxial connectors. Where necessary, the input and/or output configuration can be coplanar, strip line or microstrip transmission lines.

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