# 40 GHz LCC Platform Provides High-Reliability, SMT-Compatible Solution

## Package is ideal for defense, aerospace, high-speed communications, and ATE applications

### Executive Summary

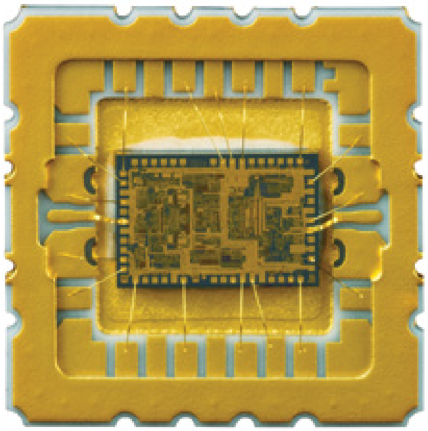
Tektronix Component Solutions has expanded its portfolio of high performance IC package technologies with a 40 GHz Leadless Chip Carrier (LCC) platform that meets stringent environmental and physical requirements.

To meet evolving customer demand for a lower cost, high-speed, surface-mount compatible package technology, the company set out to qualify a platform for customers creating next-generation communications, defense, aerospace, and automated test equipment (ATE) systems. The result was a high-speed LCC platform that can be customized to meet the requirements of a variety of low-pin count (< 100 pins) ASICs.

### Challenge

Tektronix Component Solutions set out to fill a gap in the current suite of IC package offerings in order to enable customers to achieve their performance goals in next-generation system development. The organization focused on critical customer requirements to define the appropriate package solution and established the following key criteria, based on those requirements:

- Surface-mount compatibility
- Thermally efficient construction
- Demonstrates > 20 GHz bandwidth performance
- Meets Telcordia GR-357 and MIL-PRF 38535 reliability requirements
- High-reliability, hermetic construction
- Wire-bondable


Leadless Chip Carrier (LCC)

### Solution

With the project's goals set, Tektronix Component Solutions focused its efforts on key technology and process development in five areas:

#### 1. Selecting a Suitable Package Platform

The first step in the project was to explore potential substrate and package solutions using the design rules from the best commercially available technologies. Tektronix Component Solutions' design and layout engineering team developed a number of concept packages and, through simulation, compared the options against the team's desired performance specifications. In the end, a high temperature co-fired ceramic (HTCC) substrate in a surface-mount compatible Leadless Chip Carrier (LCC) format was selected because it was found to meet the critical cost, performance and reliability requirements.

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## 2. Verifying the Package's Performance

With the fundamental package choice established through simulation, the team set out to physically confirm key capability requirements for the platform — specifically, high-speed and thermal dissipation characteristics. To validate high-speed performance, prototype samples were obtained and physically verified with a vector network analyzer (VNA). From the evaluation process, the engineering team's electrical simulation was shown to have good correlation. Evaluation of the package's electrical performance demonstrated that return loss (Figure 1) and insertion loss (Figure 2) measurements supported up to 40 GHz bandwidth.

## VNA Measurement and HFSS Model Results: Return Loss

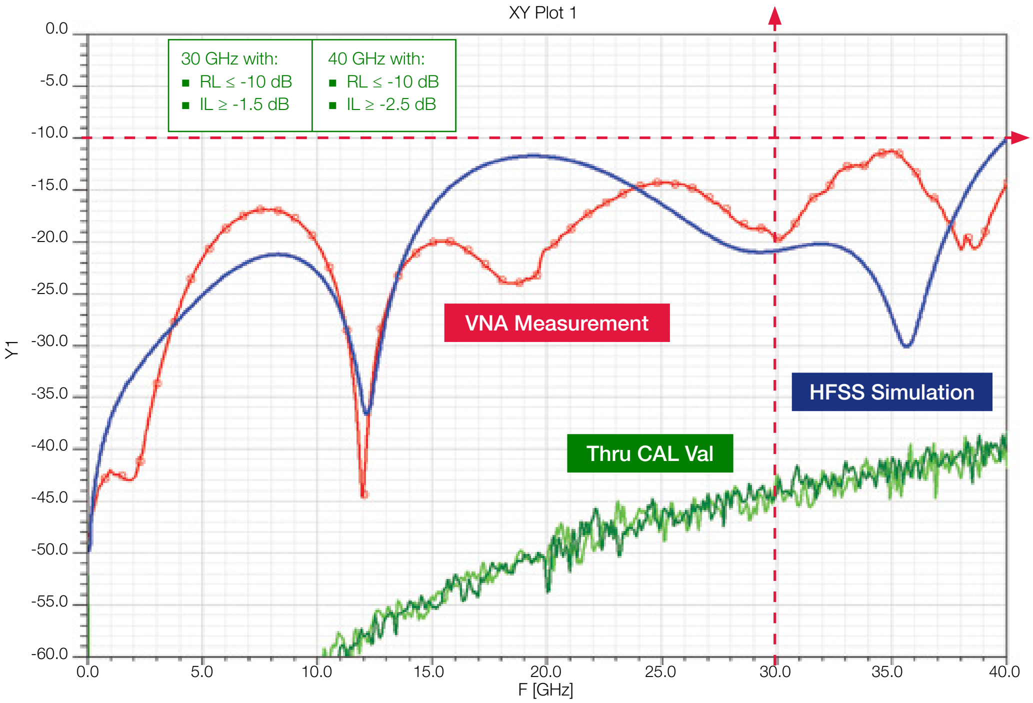

**Figure 1** shows the VNA measurements and HFSS model results for return loss expected from simulation of the package (blue line) vs. return loss actual (red line) from the physical measurement of the package. Significant agreement between the simulation and actual results demonstrate simulation accuracy.

## VNA Measurement and HFSS Model Results: Insertion Loss

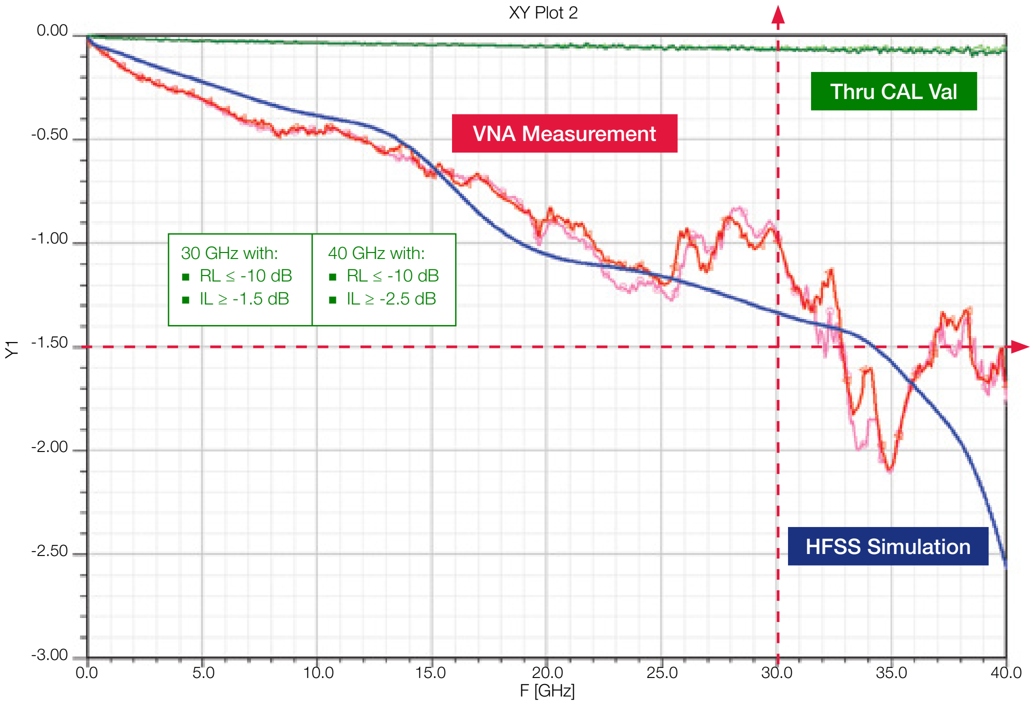

**Figure 2** shows the measurement and HFSS model results for insertion loss vs. VNA measurement of the package, again with significant agreement demonstrated between expected and actual results.

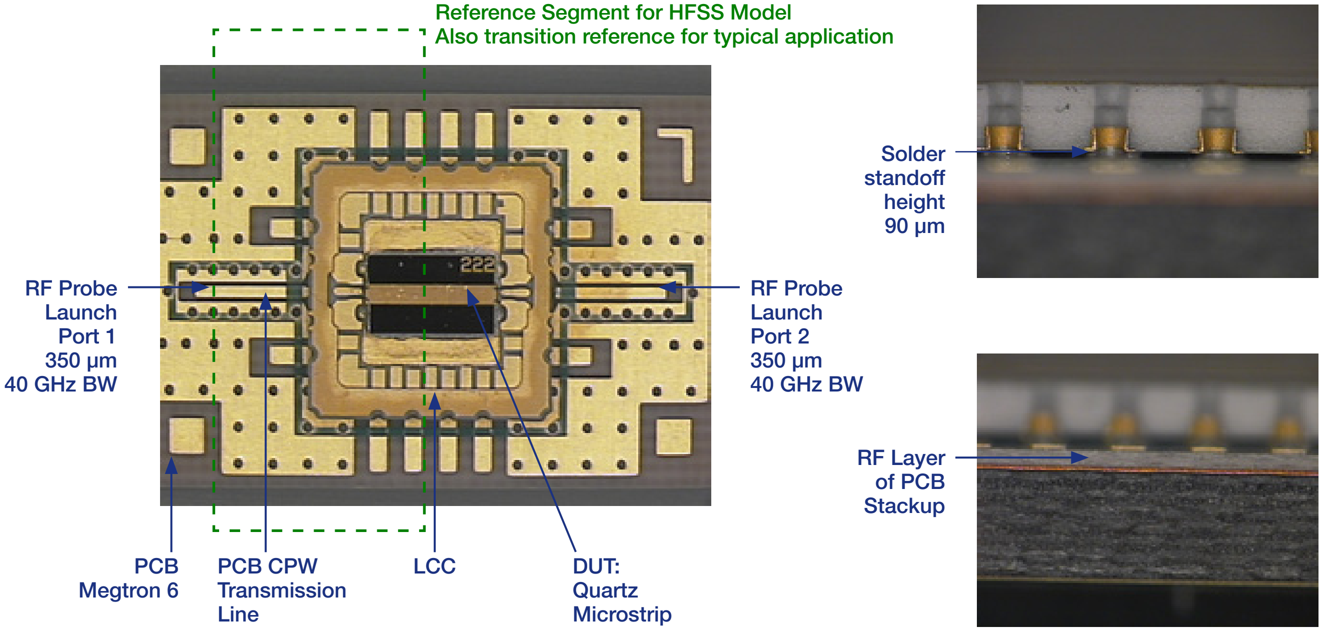

**Figure 3** displays the evaluation test vehicle used to validate bandwidth performance, including the quartz transmission line and associated wire bonds.

Thermal performance was optimized and confirmed by choosing a design that incorporates a copper-molybdenum (CuMo) slug underneath the IC. Among the various options evaluated, this approach demonstrated the best thermal construction, optimizing heat transfer out of the package while still meeting all MIL-STD-883 requirements.

## 3. Hermetic Lid Sealing

The next step in the qualification and development effort was to establish a hermetic lid sealing process to meet the appropriate MIL-STD requirements. In order to meet those requirements, the chosen process starts with an inert, gas-rich environment, then pumps down to create a high vacuum state which is later sealed using a high temperature eutectic solder seal. This process was selected for its robustness and has passed MIL-STD 883 fine leak and gross leak testing.

> “One of our biggest challenges was to qualify a die attach process that would meet the goals of our customers, including mil-standard requirements for internal vapor analysis. The die attach qualification was driven by aggressive performance targets for a high-speed, lower-cost solution.”
>
> *— Matt Borden, Mechanical Design Engineer, Tektronix Component Solutions.*

## 4. Developing an Appropriate IC Attach Methodology

The combination of the high temperature solder lid seal process and the small cavity size of the package did not allow for the use of typical organic epoxies for IC attach. At high temperatures, most epoxies begin to break down, creating concentrations of potentially harmful vapors in the package cavity well beyond that allowed by MIL-STD requirements. Although attaching the IC with a eutectic solder process eliminates the problem of epoxy outgassing, not all applications will find this a practical solution as it requires the IC to have backside metallization. As a result, Tektronix Component Solutions established an effective low-cost attach process that passed MIL-STD requirements for internal vapor content yet does not require the extra expense needed to make the IC compatible with a solder attach process.

## 5. Advanced Wire-Bonding Capability

Tektronix Component Solutions’ expertise includes advanced wire-bonding capabilities that have enabled the performance of Tektronix instrumentation for decades. Selecting the right wire configuration and achieving the appropriate bond profile is a critical factor in enabling package performance, and often requires advanced capabilities to develop an optimal solution without sacrificing bond strength integrity.

## Results

Tektronix Component Solutions identified an emerging need and proactively responded with an LCC package for high-reliability, high-performance applications. At 40 GHz, the original bandwidth objective was exceeded by 2X. Return loss was verified at ≤ -10 dB and insertion loss verified at ≥ -2.5 dB. (Figure 4). Using MIL-STD reliability tests, the package successfully completed 1,000 hours / 1,000 cycles of stress. (Figure 5).

| Bandwidth | Return Loss | Insertion Loss |
|---|---|---|
| 40 GHz | ≤ -10 dB | ≥ -2.5 dB |
| 30 GHz | ≤ -10 dB | ≥ -1.5 dB |

**Figure 4** Bandwidth, return loss and insertion loss compared.

By providing a qualified epoxy die attach option, customers have more flexibility for custom package design and can implement either epoxy or solder attach material, depending upon thermal requirements and IC configuration.

## Conclusion

With the successful qualification of the 40 GHz hermetic LCC package, Tektronix Component Solutions now offers a customizable, cost-effective, SMT-compatible platform that effectively balances size, weight, and power considerations. Leveraging the company's extensive electrical, mechanical, and test engineering expertise, a new platform is available immediately for the most demanding customer applications.

| Item | Condition | Reference Method | Sample Size | Fails | Results |
|---|---|---|---|---|---|
| **Pre-Conditioning** | 3x 260° C Peak Reflow | JESD22-A113 *(No Moisture Dwell)* | 16 | 0 | Pass |
| **High Temperature Storage** | 1,000 hrs 150° C | MIL-STD 883, TM1008, Cond B | 8 | 0 | Pass |
| **Temperature Cycling** | 1,000 cyc's -55 ~ 125° C 15min dwell | MIL-STD 883, TM1010, Cond B | 8 | 0 | Pass |
| **Hermeticity (Fine Leak)** | Post Stress, < 5.0E-8 atm cc/s He | Method 1014, Cond $A_1$ | 8+8 | 0 | Pass |
| **Hermeticity (Gross Leak)** | Post Stress, Perfluorocarbon | Method 1014, Cond $C_1$ | 8+8 | 0 | Pass |
| **Internal Gas Analysis** | Post Stress, ≤ 5,000 ppm | Method 1018 | 5+5 | 0 | Pass |
| **Wire Pull** | Post Stress, ≥ 1.8 gF | Method 2011 Cond C | 6 units / 15 wires each | 0 | Pass |
| **Die Shear** | Post Stress, ≥ 5 KgF | Method 2019 | 6 | 0 | Pass |

**Figure 5** Reliability test summary.

Contact our experienced team to discuss your application and IC packaging needs:

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