AWARD WINNING PERFORMANCE

High performance devices call for high performance test and burn-in solutions and require participation by the entire test ecosystem including contactors, sockets, the DUT board, along with the environment that testing takes place in and the methodology applied. This session provides insight to each step beginning with the development of a statistical model to identify the optimized bandwidth for spring probes. Next up is a look at environmental factors that can readily impact socket performance and thus indirectly test yield. The third presentation verifies test methodology to troubleshoot a device that is having issues in a very high performance test contactor to determine the cause of the issues and affect changes to prevent them from reoccurring. Lastly, we'll hear about the unique challenges to create an optimized test methodology for 25 to 40 GHz RF amplifiers, mixers, and down converters in LFCSP (QFN) and WLCSP packages, considering connectivity issues between DUT board and sockets.

Design of Experiments Using Spring Probe Parameters for Optimized Socket Bandwidth

Mike Fedde, Ila Pal—Ironwood Electronics, Inc.

Socket Performance vs. Environmental Conditions

Gert Hohenwarter—GateWave Northern, Inc.

This Paper

Troubleshooting Test Oscillation Problems

Jeff Sherry—Johnstech International Corporation

Optimization of Package, Socket and PC Board for 25 to 40GHz RF Devices

Carol McCuen, Phil Warwick—R&D Circuits, Inc.

Troubleshooting Test Oscillation Problems

Jeff Sherry
Johnstech International

2013 BiTS Workshop
March 3 - 6, 2013

Johnstech®

Consult. Analyze. Identify. Solve.

Getting to the Heart of the Matter with a CSI Approach

The Scene of the Crime

- Customer has problem with test setup and wants you to fix problem
- Customer provides limited knowledge of problem
- Customer only provides bad data
- Customer not sure what problem is

Consult

Initial Customer Issue

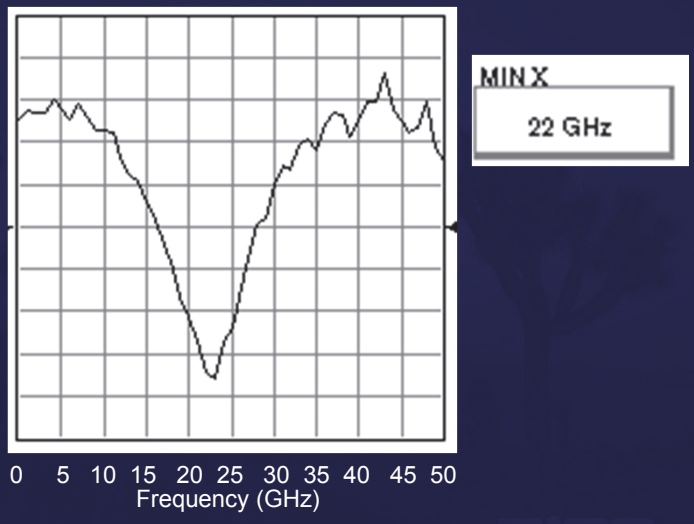
"I have been doing some measurements on the contactor in my 24 GHz application. I am concerned. I measure an open in socket and it looks OK but when I measure a shorted device, I see resonance as if the network was behaving like a filter. Without the socket, doing the same two measurements are OK with no resonance proving that my PCB to the pad is OK. Do you have any inputs on this?"

Mission, should we choose to accept:

- Find out what is causing the in-band oscillation issue
- Fix the problem without changing customer hardware (Mission Impossible?)

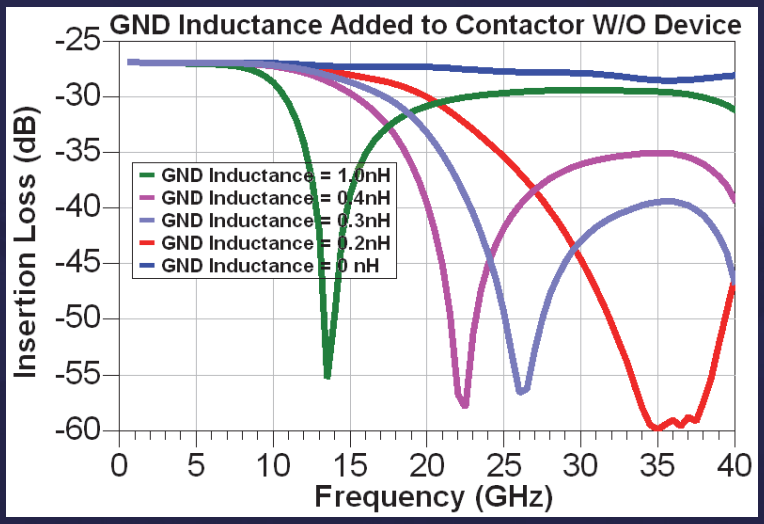
3/2013 Troubleshooting Test Oscillation Problems 5

Measured Results on Load Board With Contactor Open Circuited



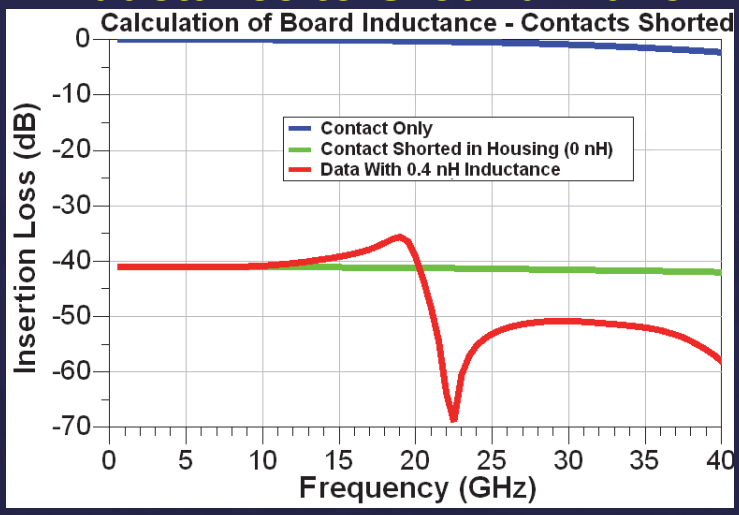
3/2013 Troubleshooting Test Oscillation Problems 6

Simulation Results: Inductance to Ground Plane – Contactor W/O Device



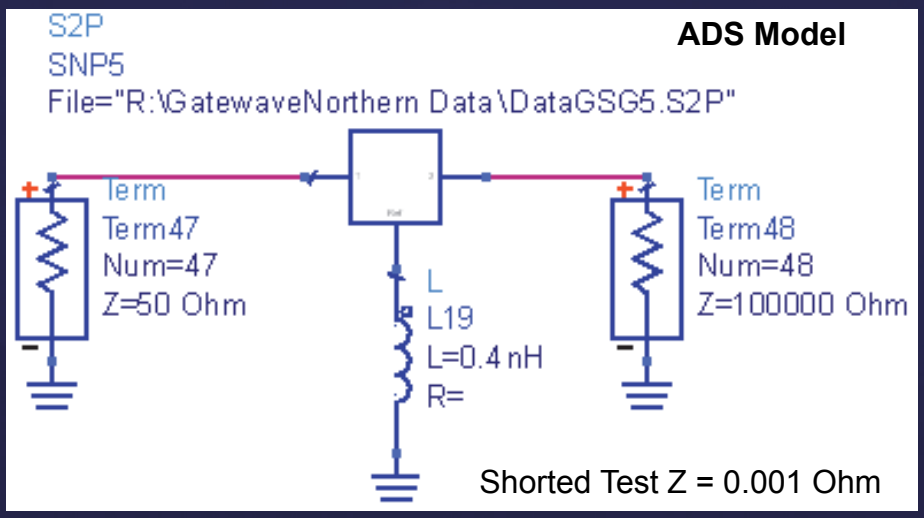
3/2013 Troubleshooting Test Oscillation Problems 7

Board Simulation: Load Board Inductance to Ground Plane



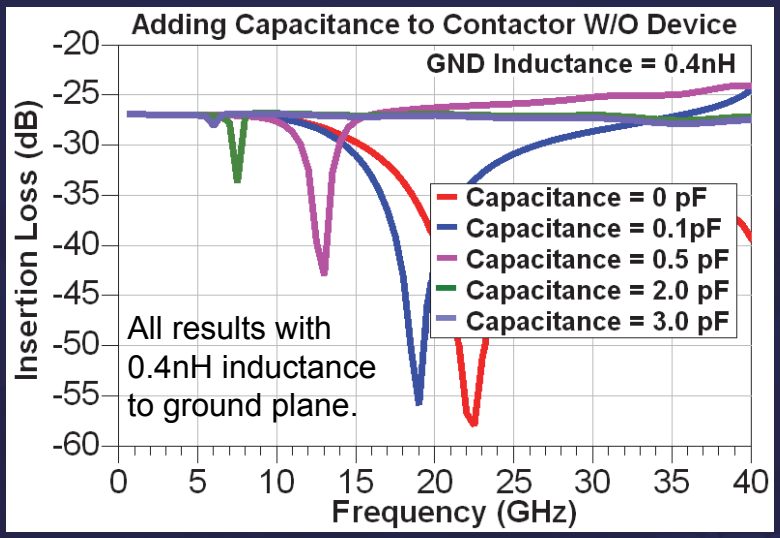
3/2013 Troubleshooting Test Oscillation Problems 8

ADS Board Simulation Model to Get Resonant Match to Measured Data



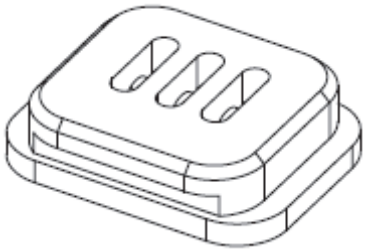
Analyze

Capacitance Sensitivity to Ground Plane – Contactor W/O Device



3/2013 Troubleshooting Test Oscillation Problems 11

Ground Insert – Inductance Calculation (Back of Envelope Estimate)



$$L = 2l\left[2.303\log(4l/d) - 1 + \mu/4 + (d/2l)\right]$$

In this equation, **L** is the inductance in nH (10^{-9} henry), ***l*** is the length and ***d*** is the diameter of the wire/rod (both in cm). **μ** is the permeability of the material (=1.0, except for iron and other ferromagnetic materials).

Wire Diameter (***d***) = cm

Wire Length (***l***) = cm

Permeability (**μ**) = 1.0 (1.0 EXCEPT for IRON)

Calculate Inductance | Clear Calculator

Inductance = nH

Equivalent Diameter

Equivalent Area = 6.9 mm^2

$\pi * \left(\frac{d}{2}\right)^2 = 6.9\ mm^2$

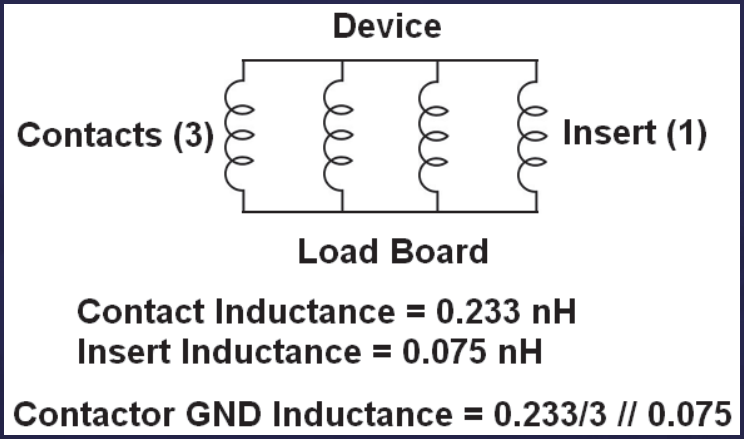
d = 2.964 mm

Insert Inductance = 0.075 nH

3/2013 Troubleshooting Test Oscillation Problems 12

Paper #3
6

Contactor Ground Inductance Calculation



Contact Inductance = 0.233 nH
Insert Inductance = 0.075 nH

Contactor GND Inductance = 0.233/3 // 0.075

Inductance to GND of Design = 0.04 nH

Identify

The Suspects:

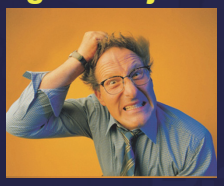
- Load Board
- Contactor
- Device/Chip

ADS Board Simulation Model to Get Resonant Match to Measured Data

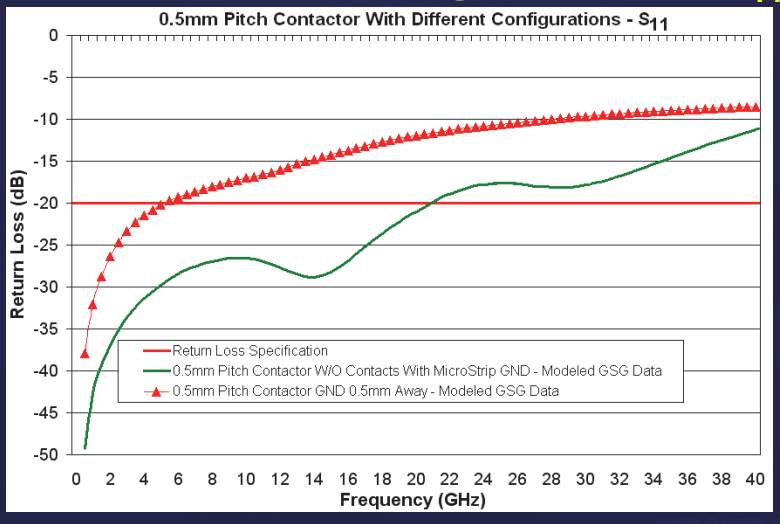
Customer: "I am very impressed with the results. I see the resonance when I have a shorted device in the socket, not an open. A device with all pins shorted to GND with conductive tape. Could you insert a short in the simulation and see what you get?"

Response: It sounds like you have a very long return path or ground is broken, try removing the adjacent contacts to RF signal.

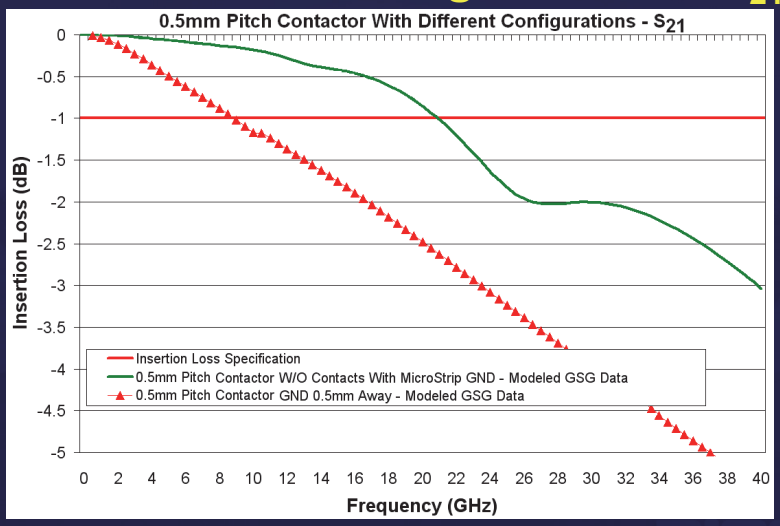
Customer: ?#%&@!*



HFSS Model – Simulation Results With Different Configurations – S_{11}



HFSS Model – Simulation Results With Different Configurations – S_{21}

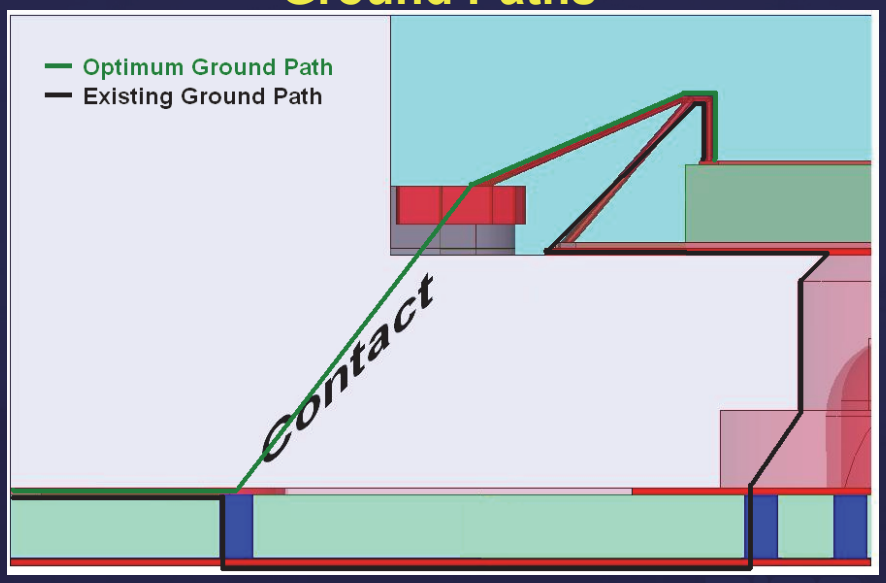


Customer Response (2 weeks later)

"I removed adjacent GND contacts from the contactor on a 24GHz pin and it improved the performance by 6dB.

Previous to this these contacts were grounded at the PCB pad and open at the DUT pad (not internally down bonded to GND). What do you think?"

Ground Paths



3/2013 Troubleshooting Test Oscillation Problems 19

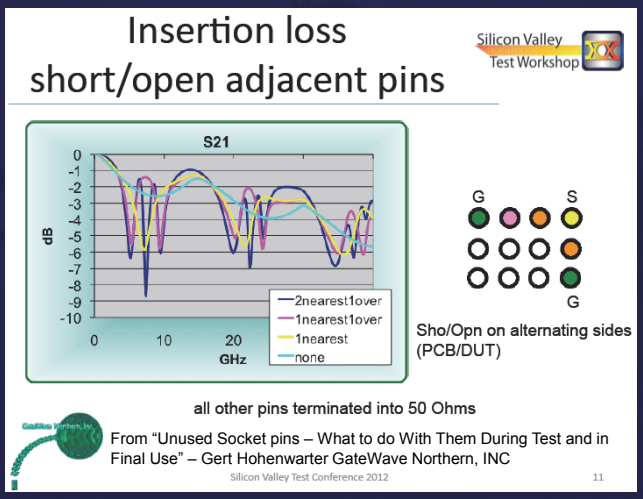
Calling on Outside Resources to Substantiate the Evidence

3/2013 Troubleshooting Test Oscillation Problems 20

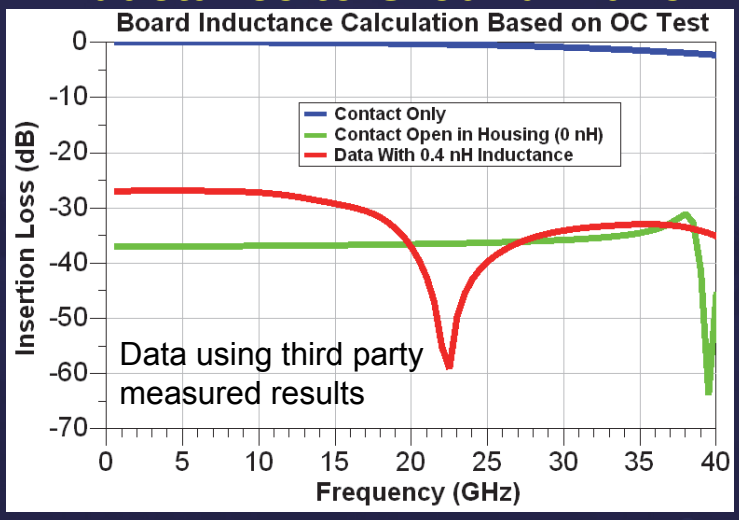
Third Party Validation: Test House Response

- In the following example the third party test house shows that the contact lengths are much longer (5 mm) and the first adverse resonance is observed at about 6 GHz.
- Linear scaling would then suggest that this happens at 40 GHz for 0.75 mm long contacts.

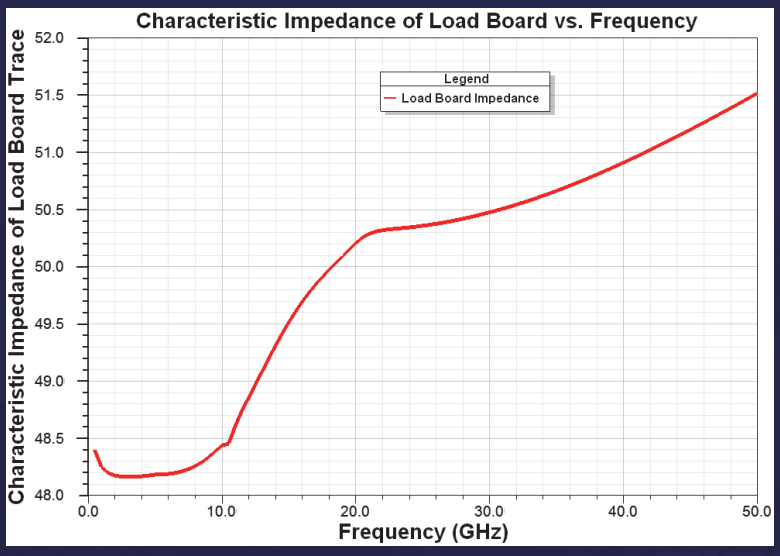
Third Party Validation: Test House Relevant Graphic



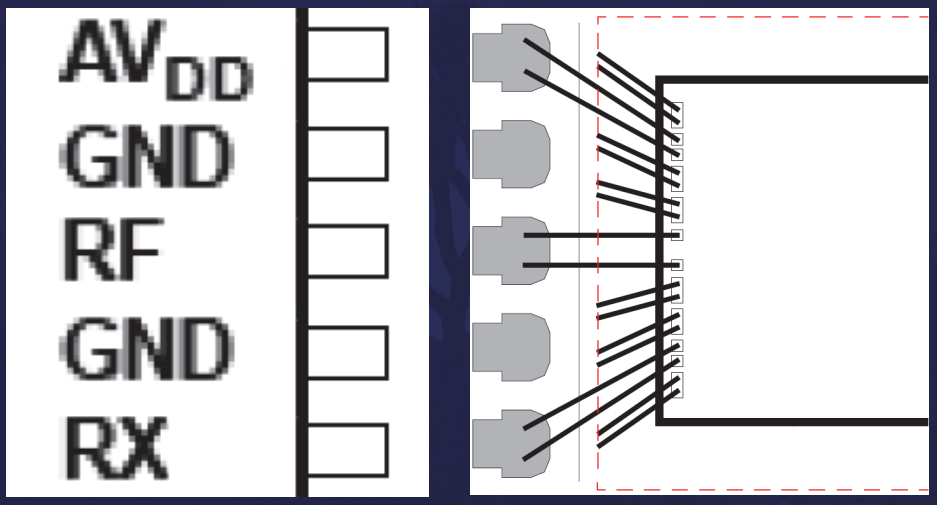
Board Simulation: Load Board Inductance to Ground Plane



Customer Load Board Impedance

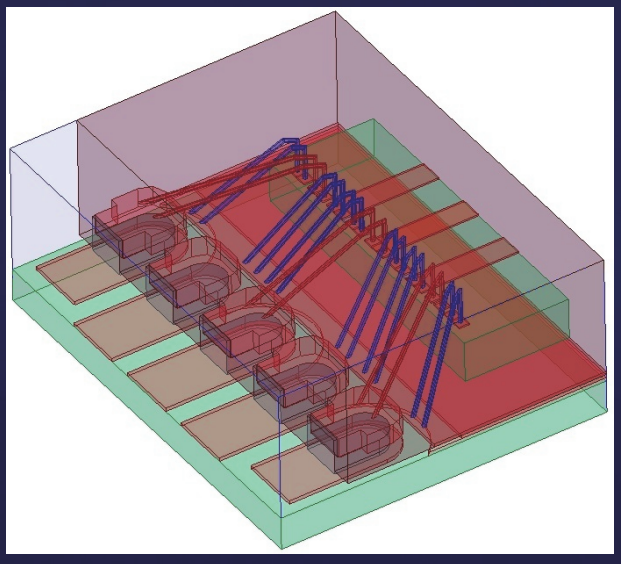


0.5mm Pitch Customer Package and Layout



3/2013 Troubleshooting Test Oscillation Problems 25

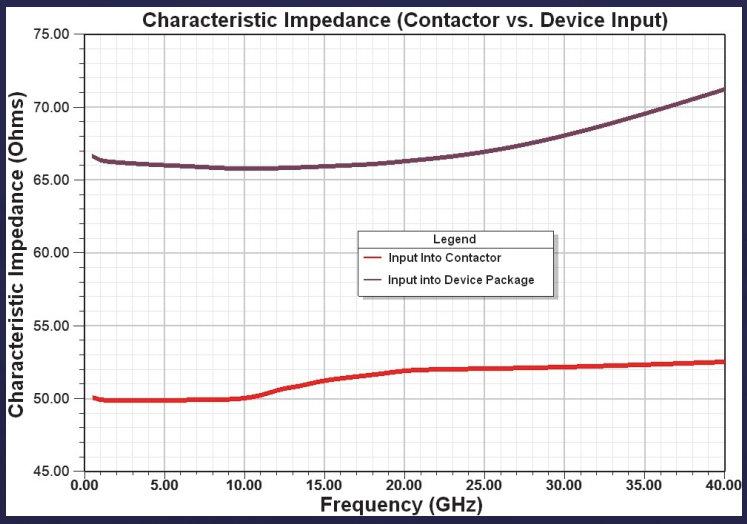
Customer Wire Bonded Package



Peripheral pads adjacent to RF signal not tied to device ground directly to create GND-SIG-GND configuration

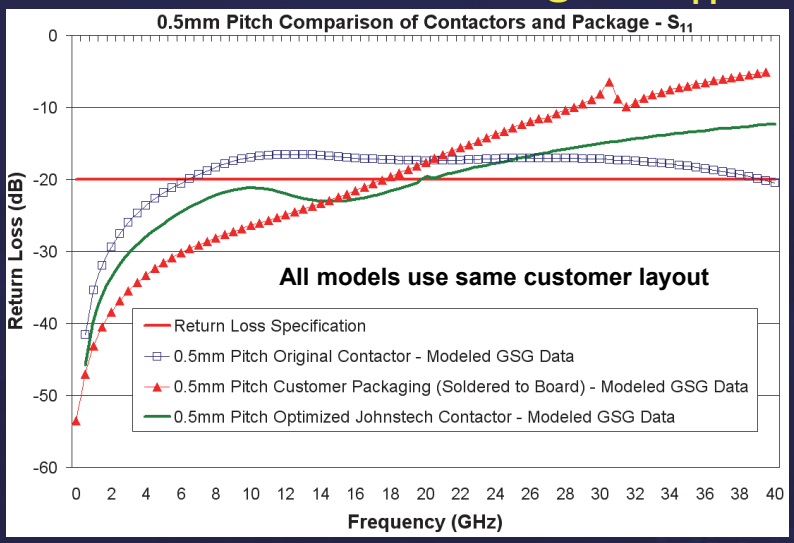
3/2013 Troubleshooting Test Oscillation Problems 26

0.5mm Pitch Contactor – Input Impedance of Contactor vs. Device



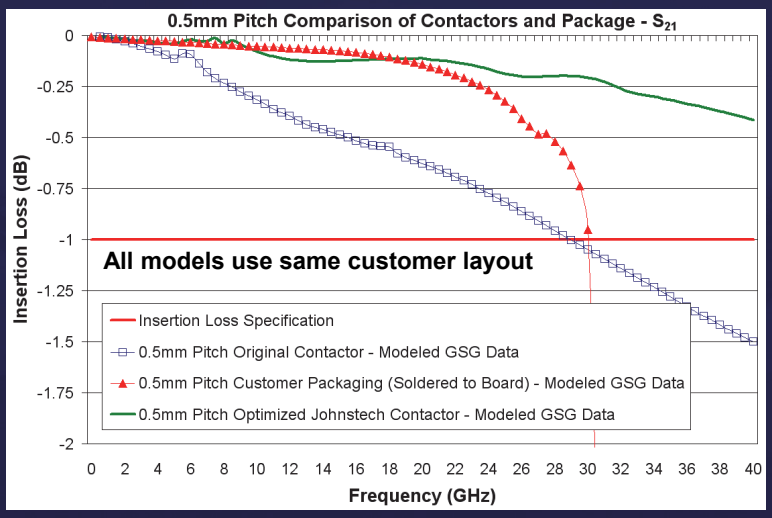
3/2013 Troubleshooting Test Oscillation Problems 27

0.5mm Pitch Comparison of Contactors vs. Package – S_{11}

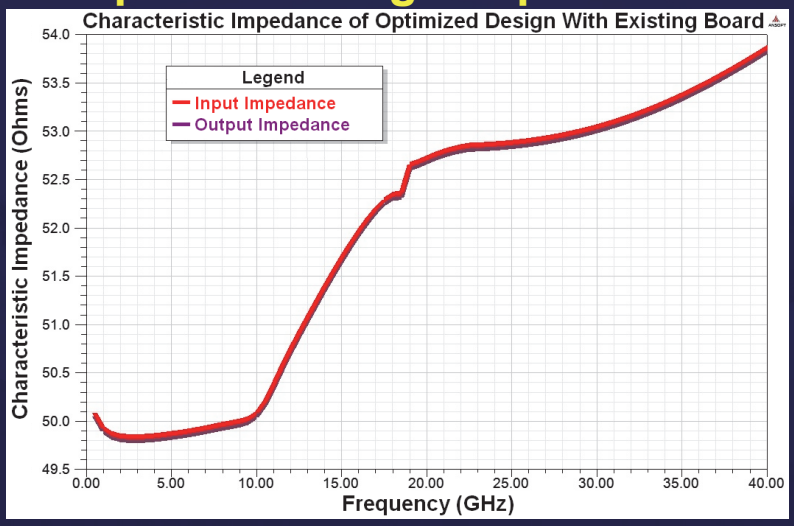


3/2013 Troubleshooting Test Oscillation Problems 28

0.5mm Pitch Comparison of Contactors vs. Package – S_{21}

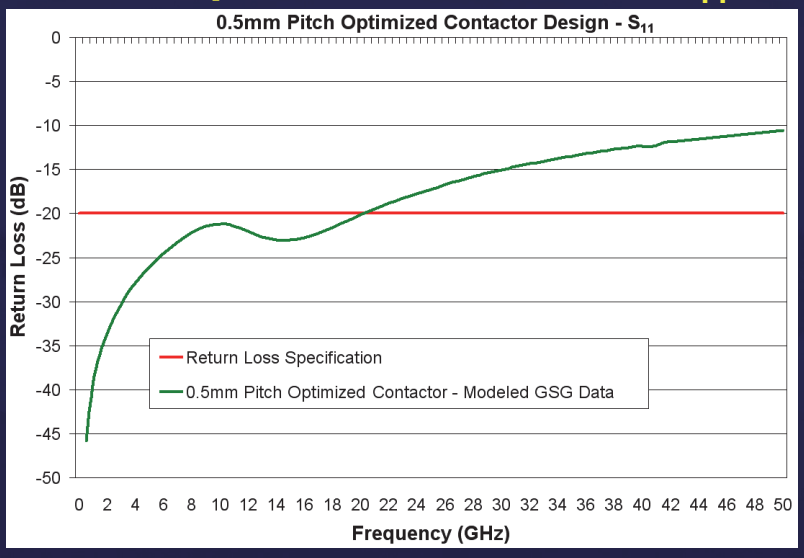


0.5mm Pitch Contactor Improved Design Impedances

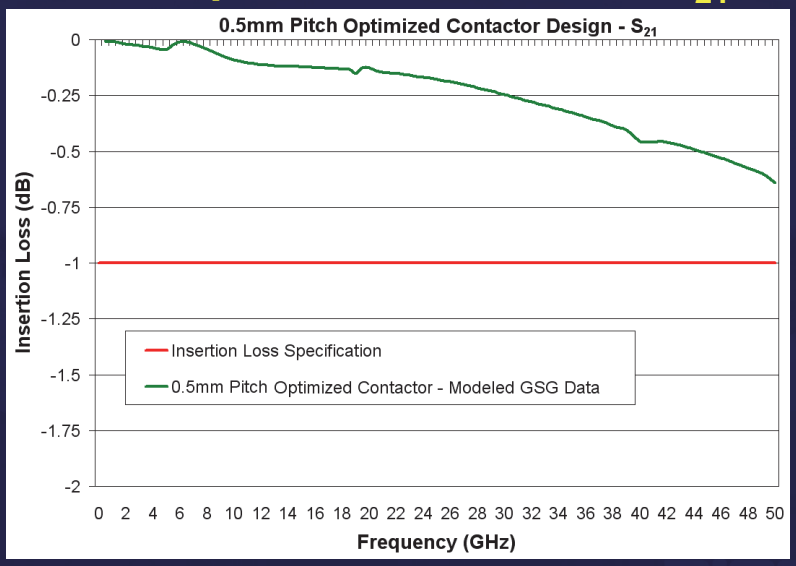


Solve

The Optimized Solution – S_{11}

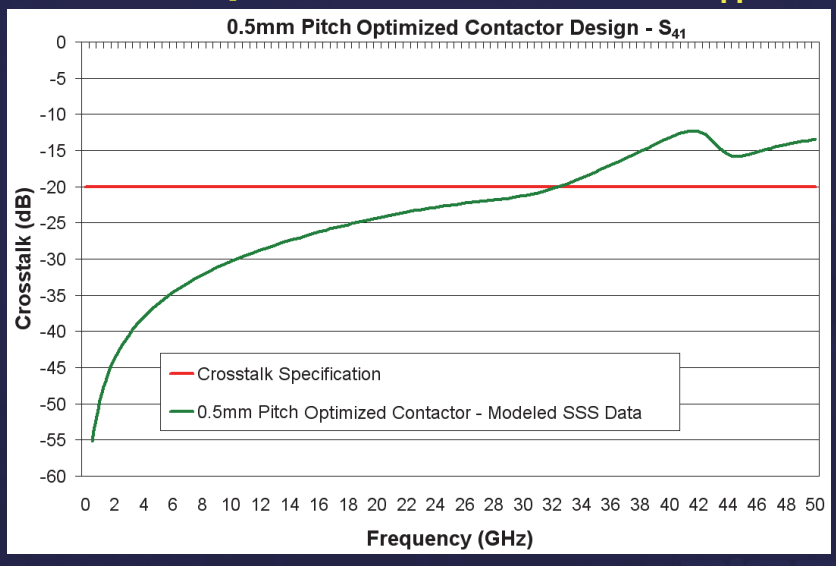


The Optimized Solution – S_{21}



3/2013 Troubleshooting Test Oscillation Problems 33

The Optimized Solution – S_{41}



3/2013 Troubleshooting Test Oscillation Problems 34

Customer Perspective

"I'd like to extend my thanks to you (and your other colleagues) for all of your work and diligence in finishing what I suspect was some difficult hardware to manufacture.

In addition to my many thanks for developing a test solution to my project, I owe you some feedback on the contactor that you provided me a couple of months ago. I can tell you that we now have a high-confidence isolation measurement."

Conclusion

Load Board

•Shorter ground paths result in better electrical performance
•Coaxial connections can achieve better RF performance

Contactor

•Design also improved EMI and ESD shielding, RF isolation, thermal capability, ground inductance and RF performance

Package / Device

•Wire bonds are not a good idea for high frequency designs
•Device packaging has a big impact on device performance

Design for Testability