

SEVENTEENTH ANNUAL

BiTS

Burn-in & Test Strategies Workshop

TM

March 6 - 9, 2016

**Hilton Phoenix / Mesa Hotel
Mesa, Arizona**

Archive- Session 4

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Session 4

Marc Mössinger
Session Chair

BiTS Workshop 2016 Schedule

Performance Day

Tuesday March 8 - 8:00 am

Frequently High

"High Speed BGA Sockets from a System Perspective"

Don Thompson - R&D Altanova

"A Solution of Test, Inspection and Evaluation for Blind Signal Waveform on a Board"

Tatsumi Watabe, Makoto Kawamura, Hiroyuki Yamakoshi - S.E.R. Corporation

"Device Packaging and How It Affects RF Performance"

Noureen Sajid, Jeff Sherry - Johnstech International

"Automotive Radar Test"

Jason Mroczkowski - Xcerra Corporation

Device Packaging and How it Affects RF Performance

Noureen Sajid and Jeff Sherry
Johnstech International



2016 BiTS Workshop
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Johnstech®

Objective

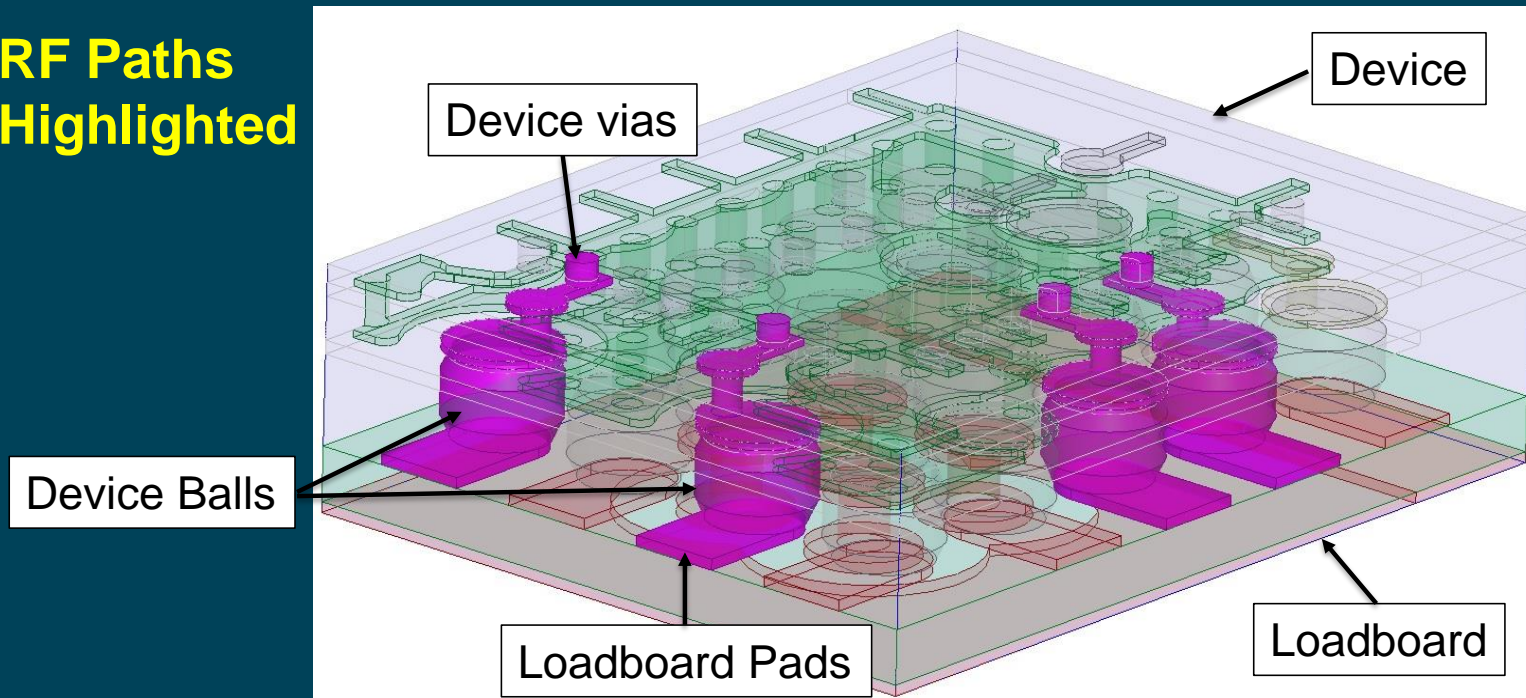
- Illustrate device packaging features that affect device performance at higher frequencies through modeling and simulation
- Highlight the modeled performance of an RF optimized test contactor in a complete system
 - An RF test system must incorporate a contactor that has validated RF performance compared to the device under test
- Draw attention to the interdependency of the components that constitute a test system
 - Collaborating the development of the different components that evolve into a high frequency test system is crucial above 50 GHz.

Contents

- Device packaging features
- Effects of Device ball size variation
- Grounding effects relative to RF I/Os
- Contactor performance
- RF performance of Edge vs. Field connections in contactor
- System performance
- Summary

BGA Package Soldered to 50 Ohm Load Board (Without Contactor) - HFSS Model

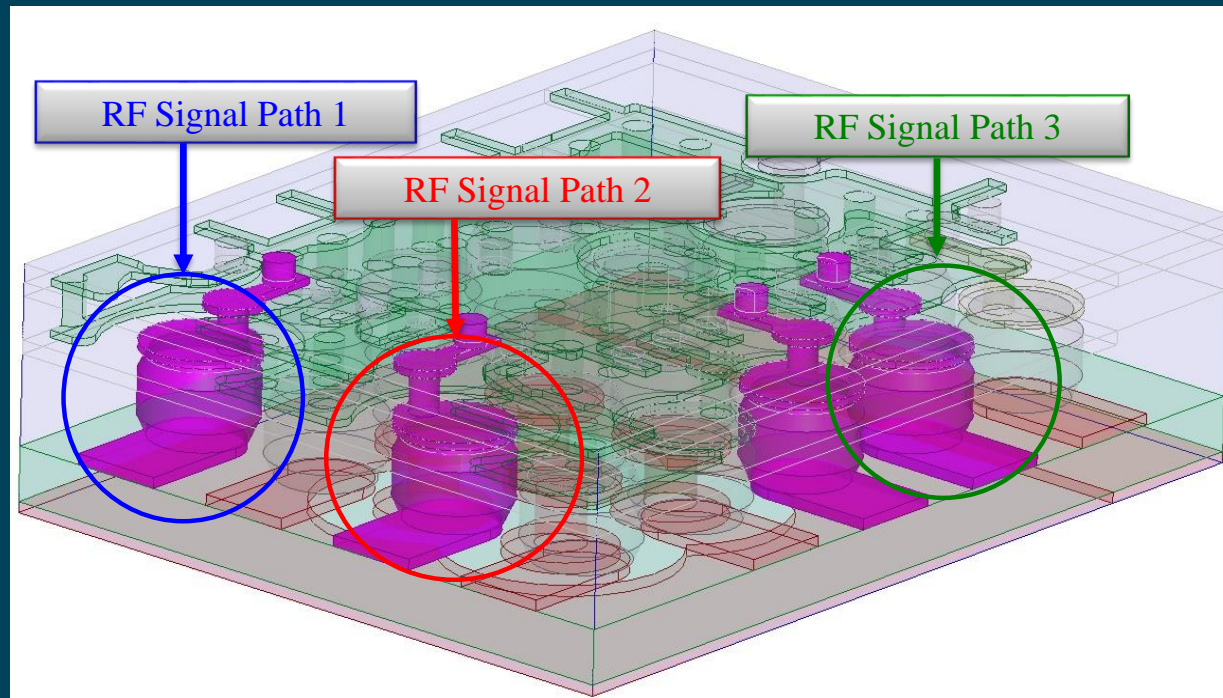
RF Paths
Highlighted



Device package has big impact on system performance

BGA Package Soldered to 50 Ohm Load Board (Without Contactor) – RF I/Os

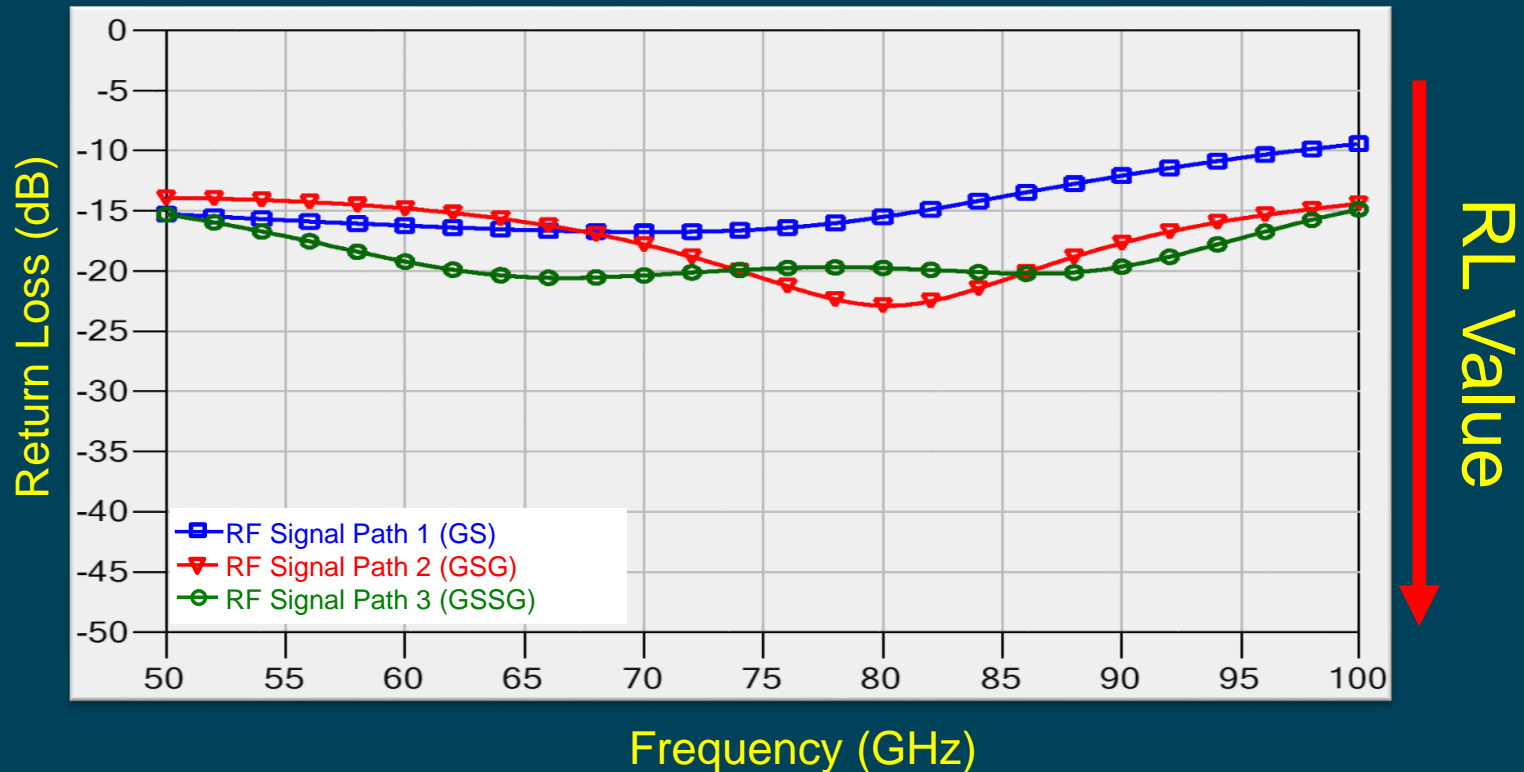
RF Paths
Highlighted



BGA Package Soldered to 50 Ohm Load Board (Without Contactor) - Path Definitions

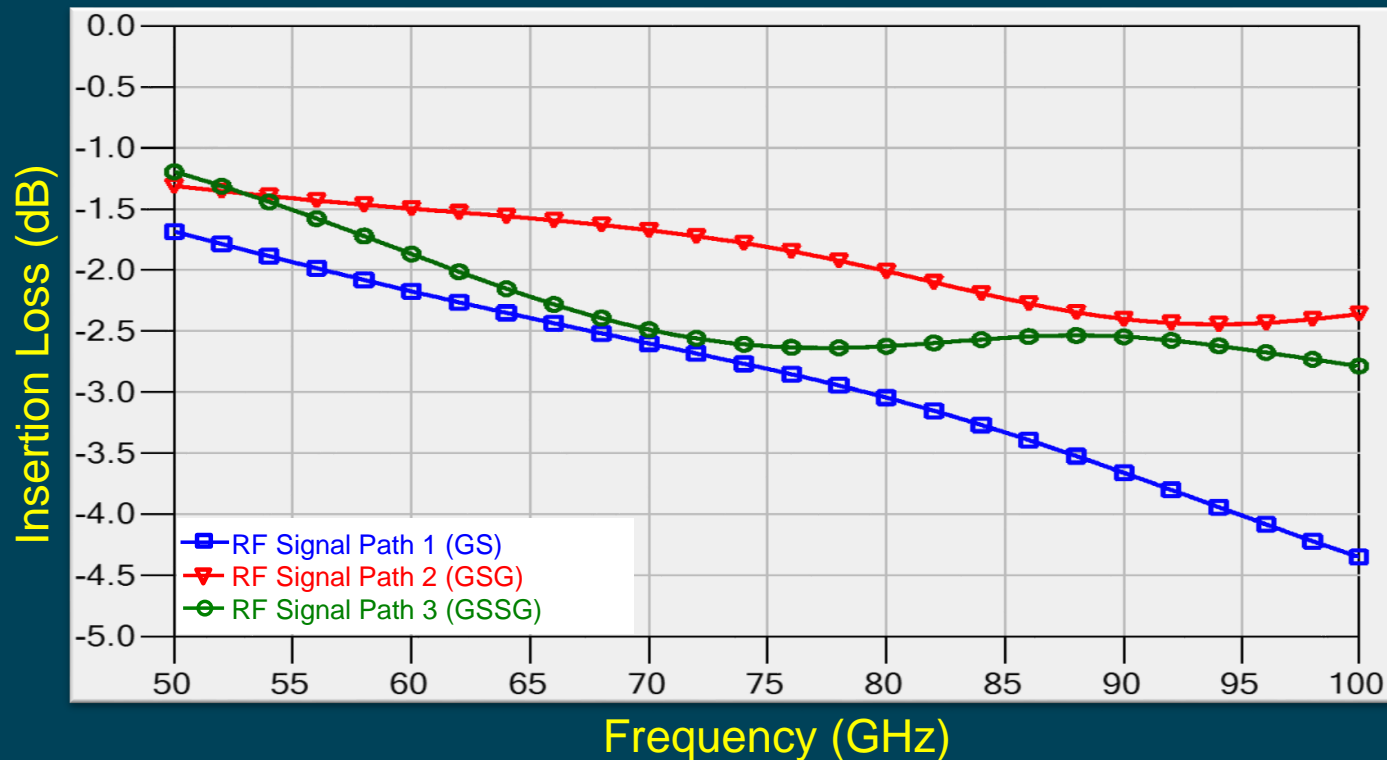
- RF Signal Path 1 (GS)
 - Positioned at edge of package and adjacent to a ground path
- RF Signal Path 2 (GSG)
 - Has a ground path on either side
- RF Signal Path 3 (GSSG)
 - Situated between a ground and high frequency path
 - Part of a differential pair
- Package Ball features:
 - Diameter – 0.20mm
 - Pitch – 0.40mm

BGA Package Soldered to 50 Ohm Load Board (Without Contactor) – S_{11}



Differential path has more consistent reflections in device

BGA Package Soldered to 50 Ohm Load Board (Without Contactor) – S_{21}

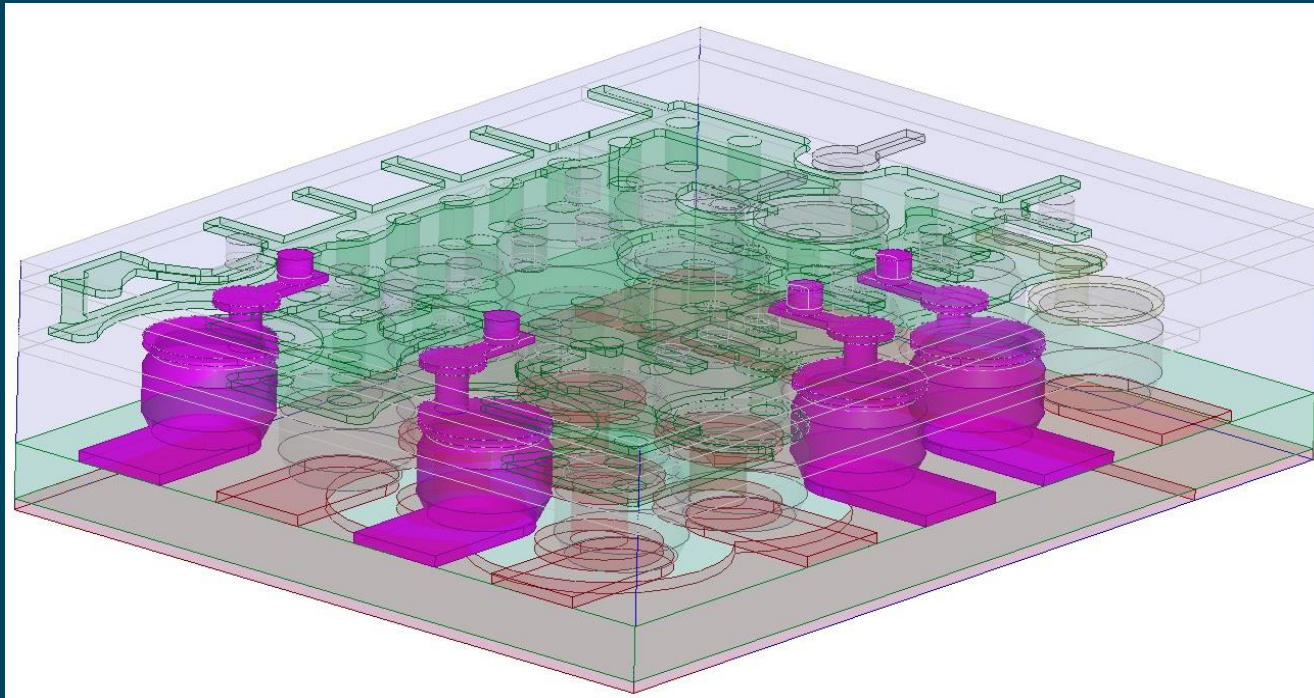


IL Value

Signal integrity is better in a single-ended path

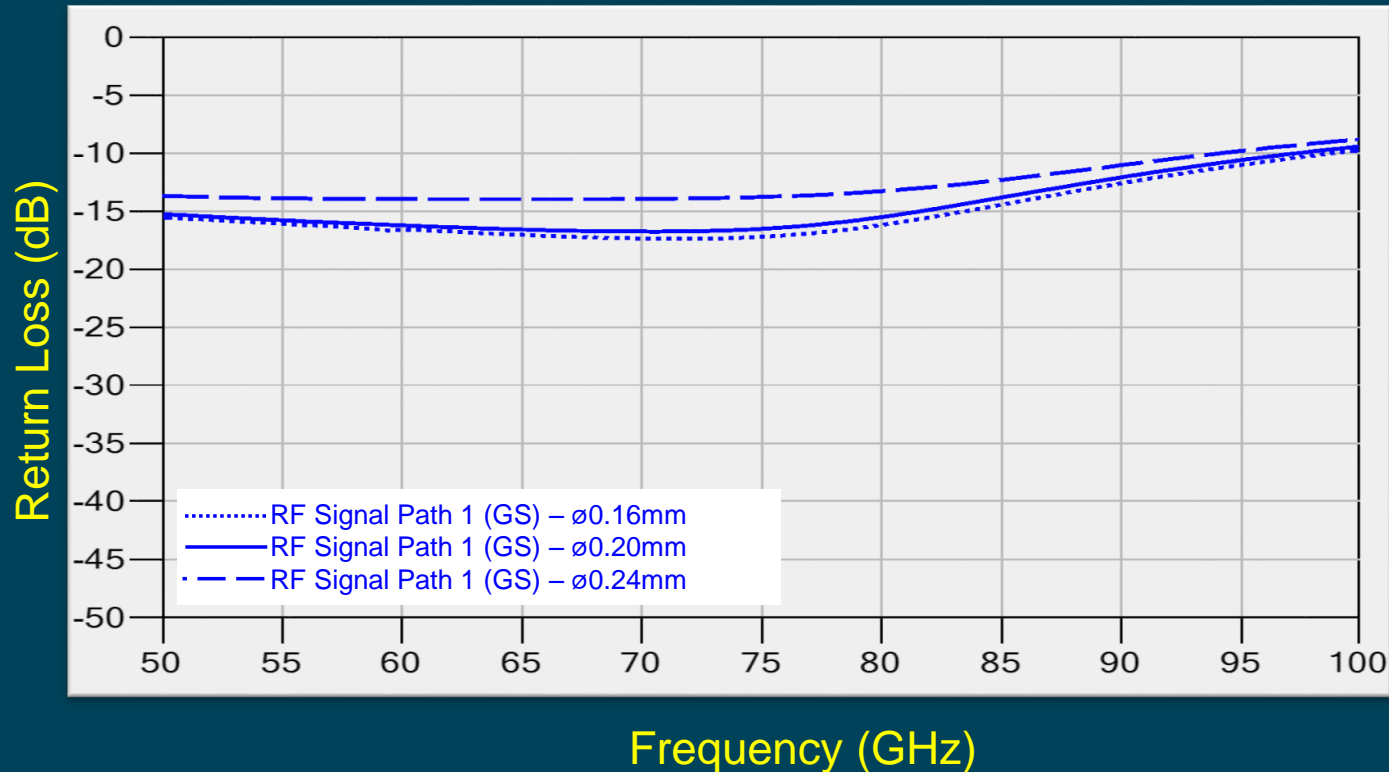
BGA Package Performance: Effects of Ball Diameter Variation

BGA Package Soldered to 50 Ohm Load Board (Without Contactor) – Only Ball Diameters Varied



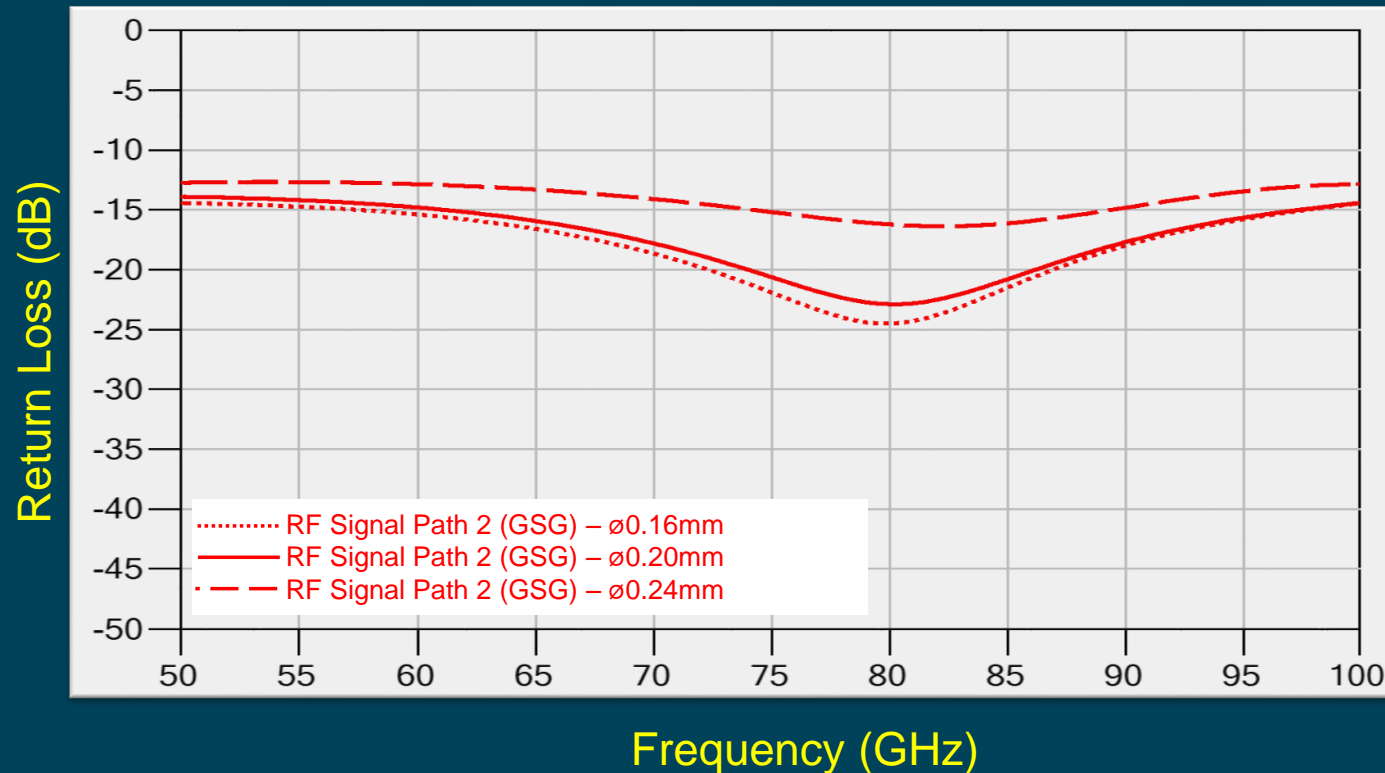
Varying ball diameters & keeping all other features unchanged

Package Ball Diameters Varied RF Signal Path 1 - Return Loss

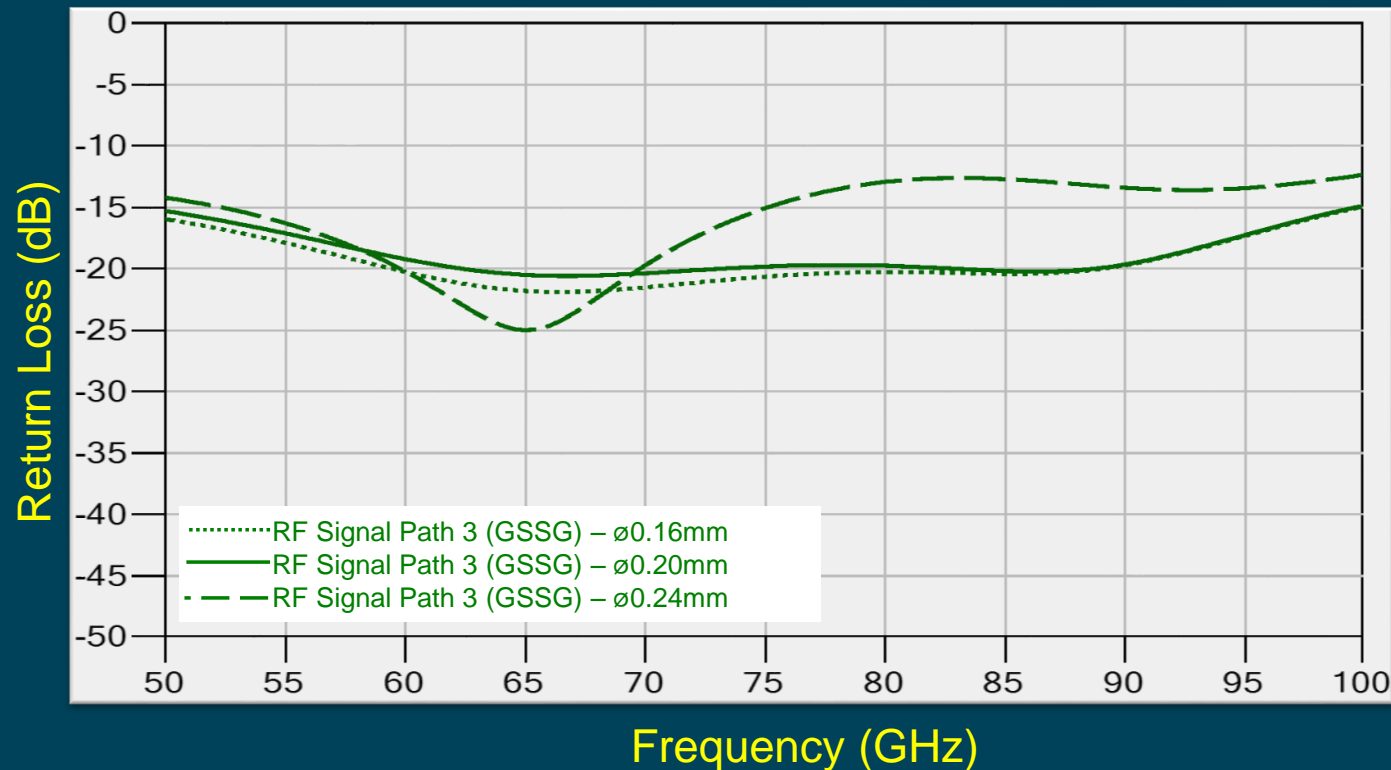


Large ball sizes are more prone to impedance mismatches

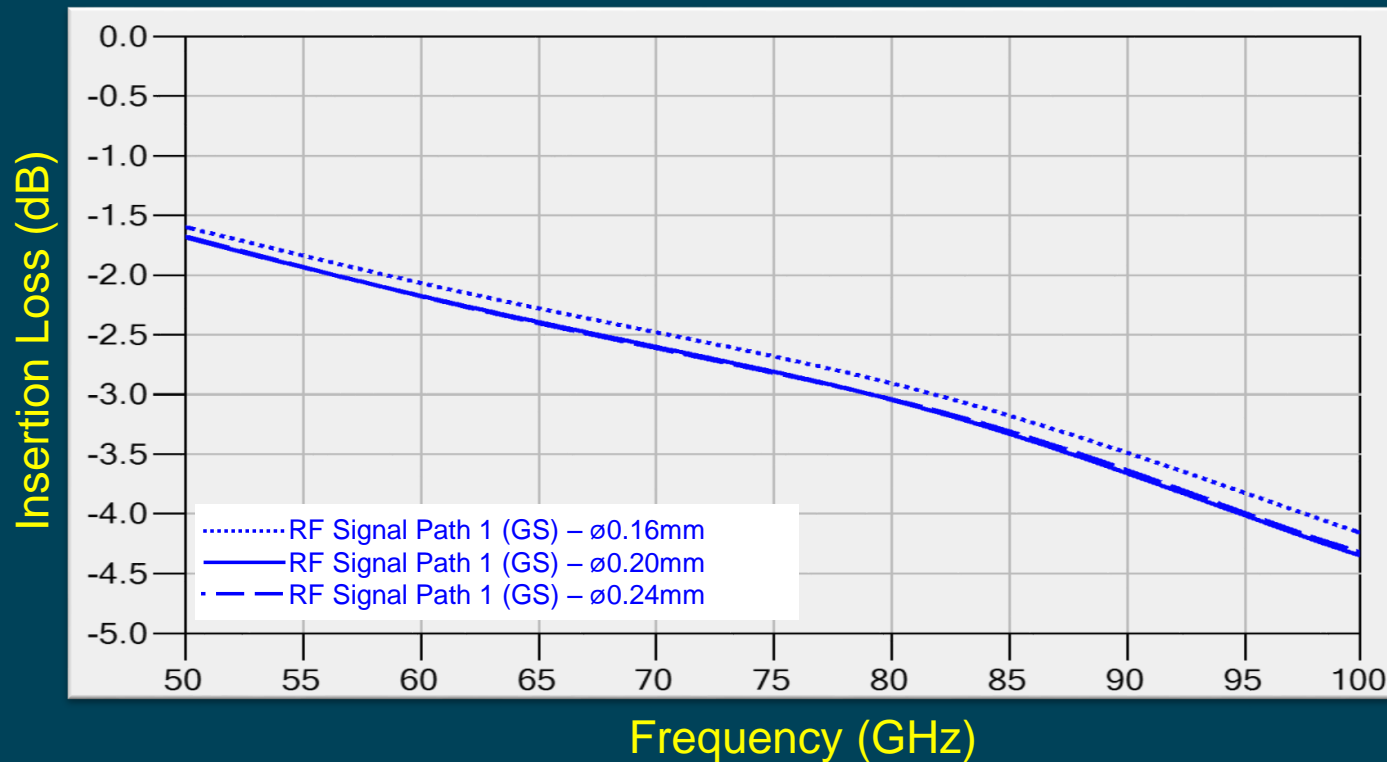
Package Ball Diameters Varied RF Signal Path 2 - Return Loss



Package Ball Diameters Varied RF Signal Path 3 - Return Loss

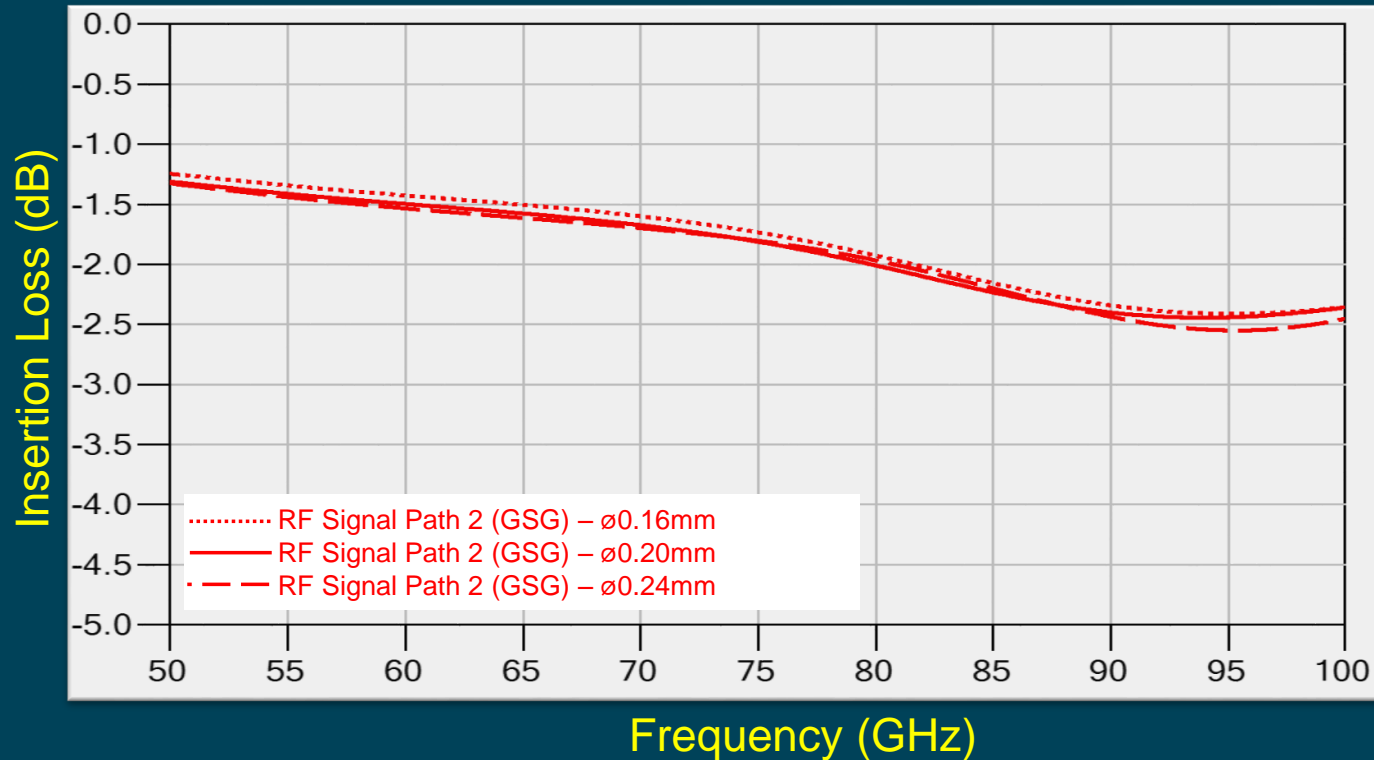


Package Ball Diameters Varied RF Signal Path 1 - Insertion Loss

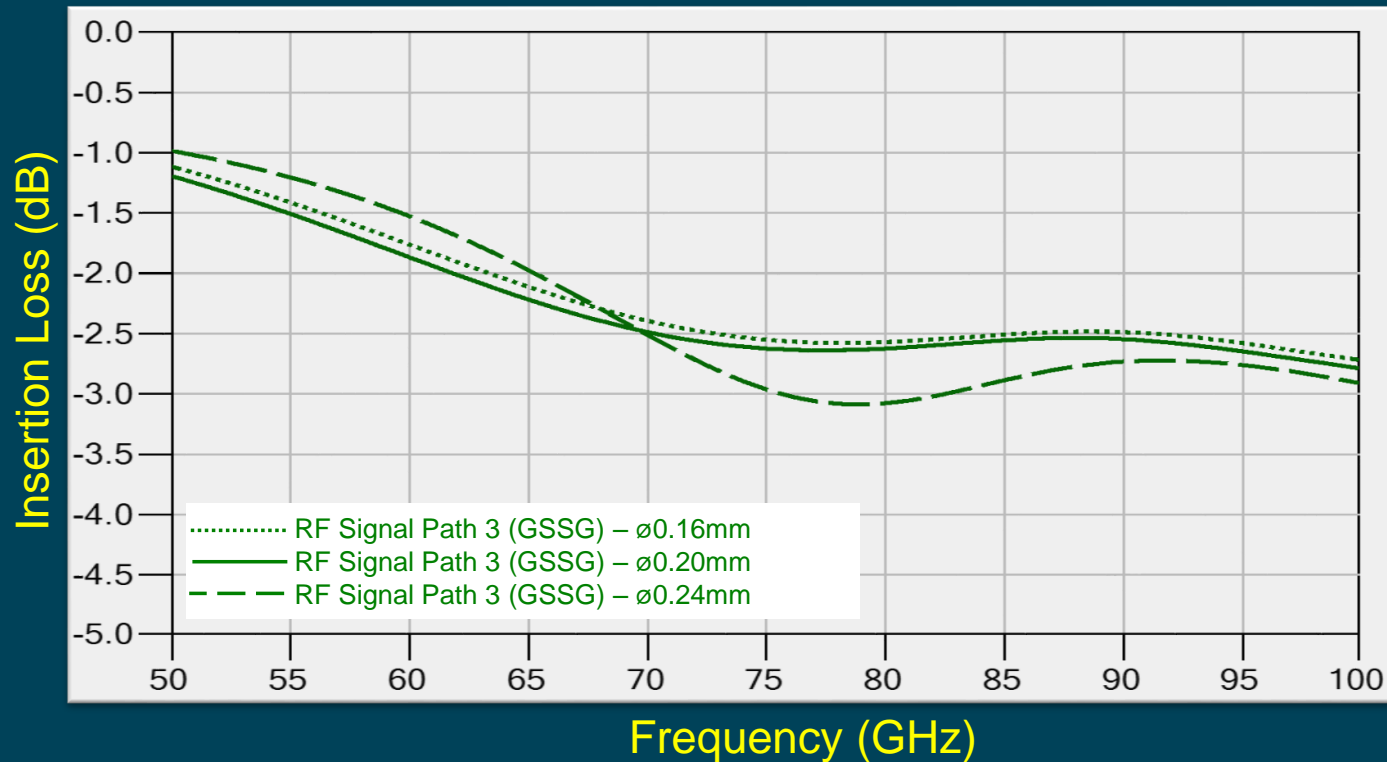


Smaller ball sizes have shorter paths resulting in higher BW

Package Ball Diameters Varied RF Signal Path 2 - Insertion Loss

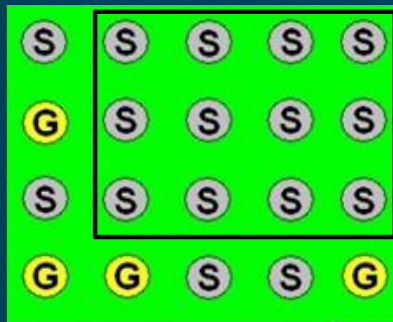
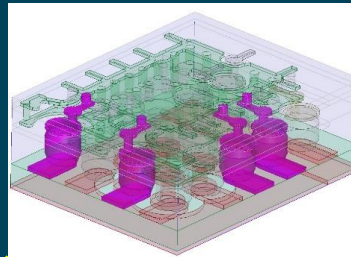


Package Ball Diameters Varied RF Signal Path 3 - Insertion Loss



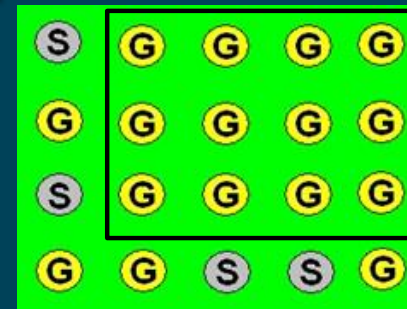
BGA Package Performance: Effects of Grounding Relative to RF I/Os

BGA Package Soldered to 50 Ohm Load Board (Without Contactor)



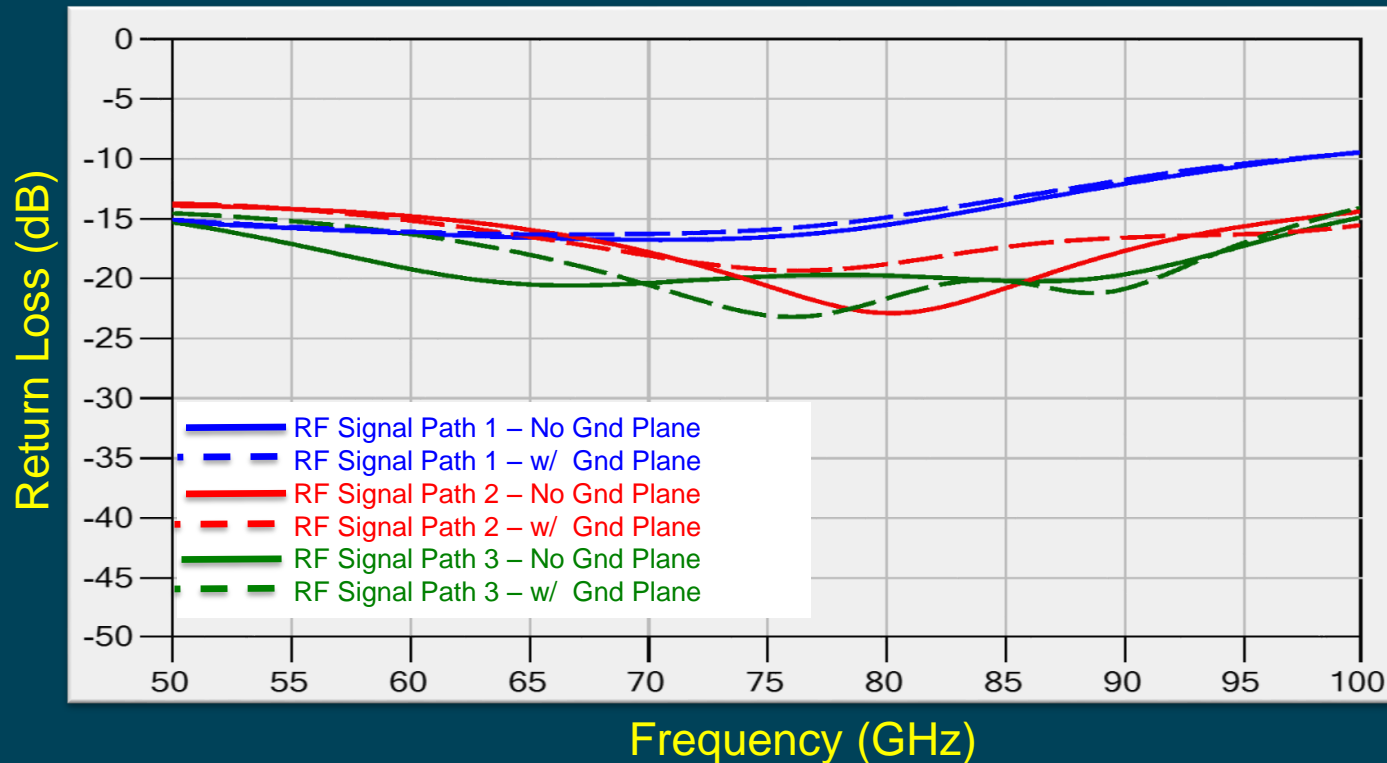
With No Ground Plane

- Ball Diameter - 0.20mm
- Ball Pitch - 0.40mm



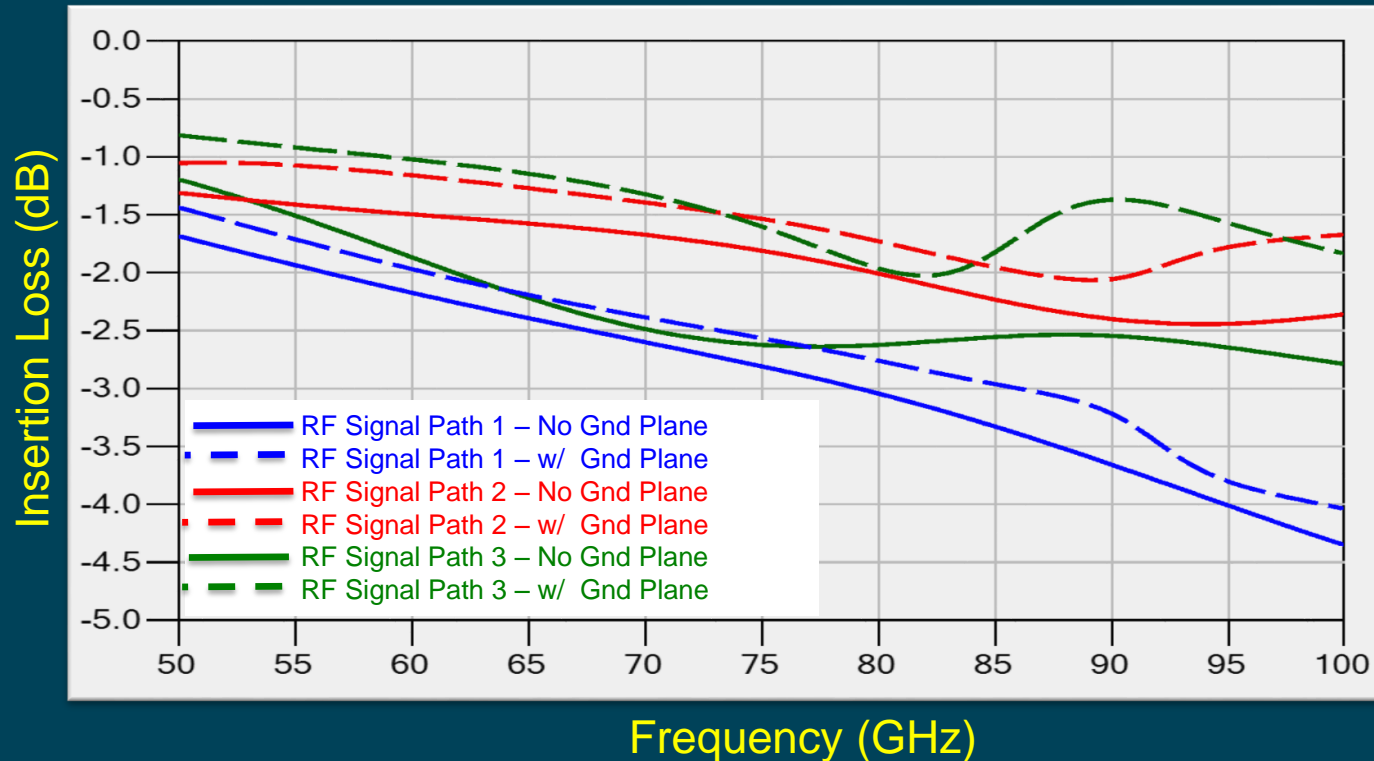
With Ground Plane

0.4mm Pitch BGA Package 0.20mm Ball Size With and Without Ground Plane – S_{11}



Grounds impact impedance based on their location

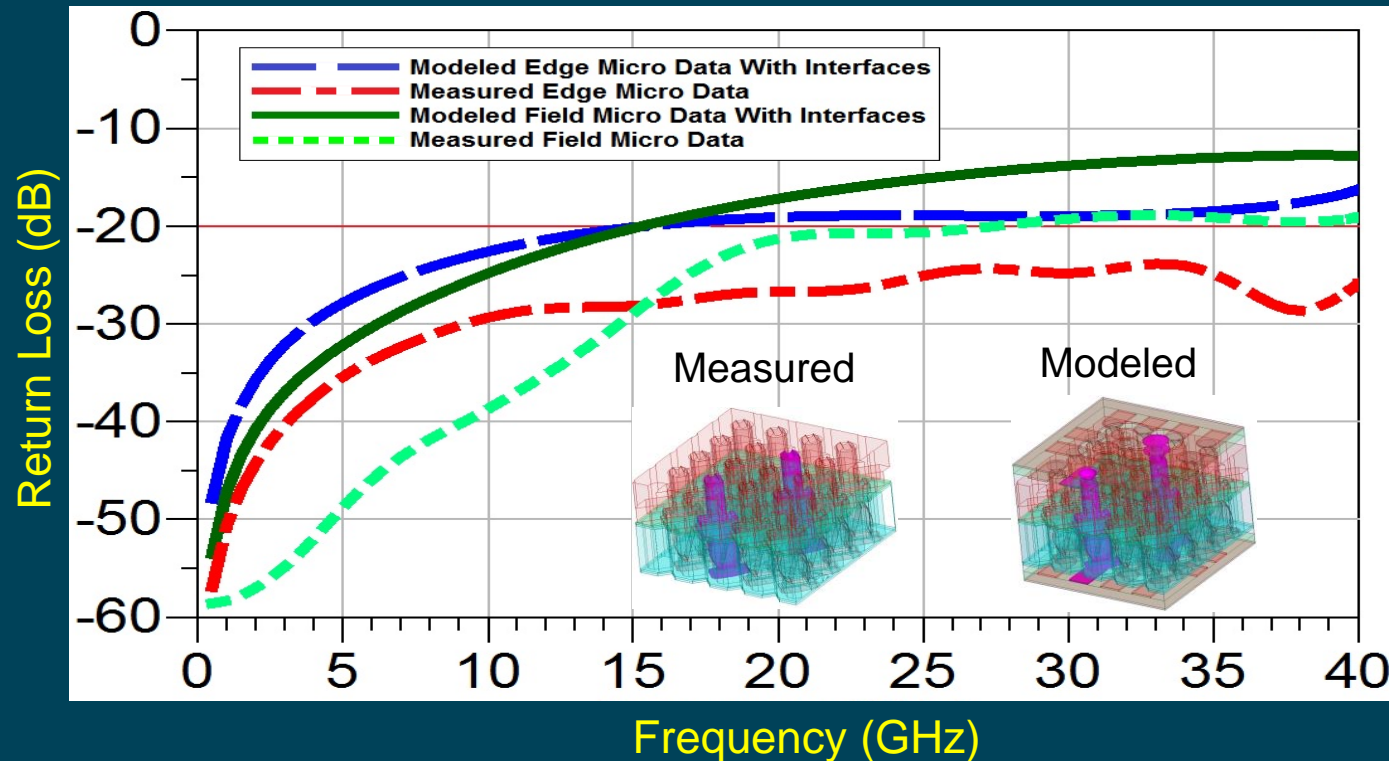
0.4mm Pitch BGA Package 0.20mm Ball Size With and Without Ground Plane – S_{21}



Grounds improve signal transmission

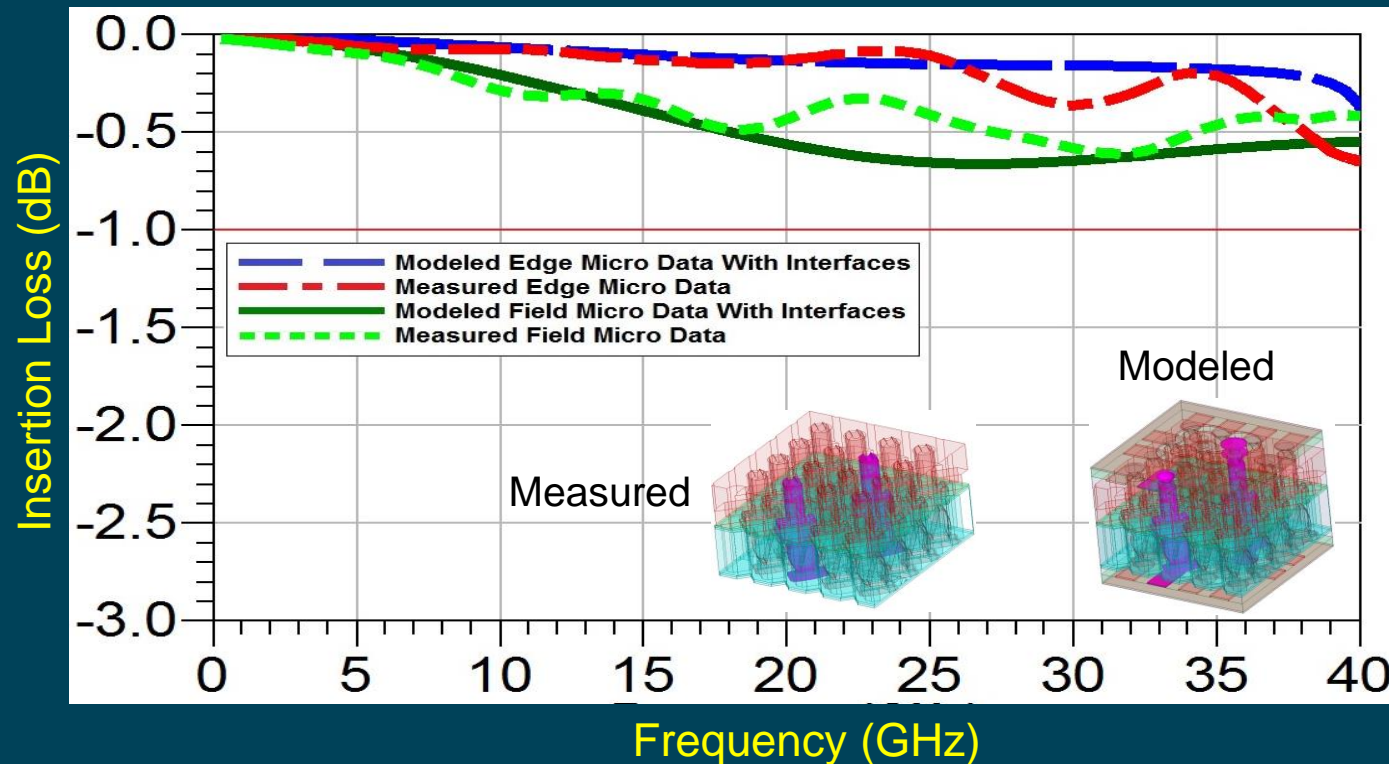
Contactor Performance

0.4mm Pitch IQtouch Micro Measured vs. Modeled (Edge vs. Center) – S_{11}



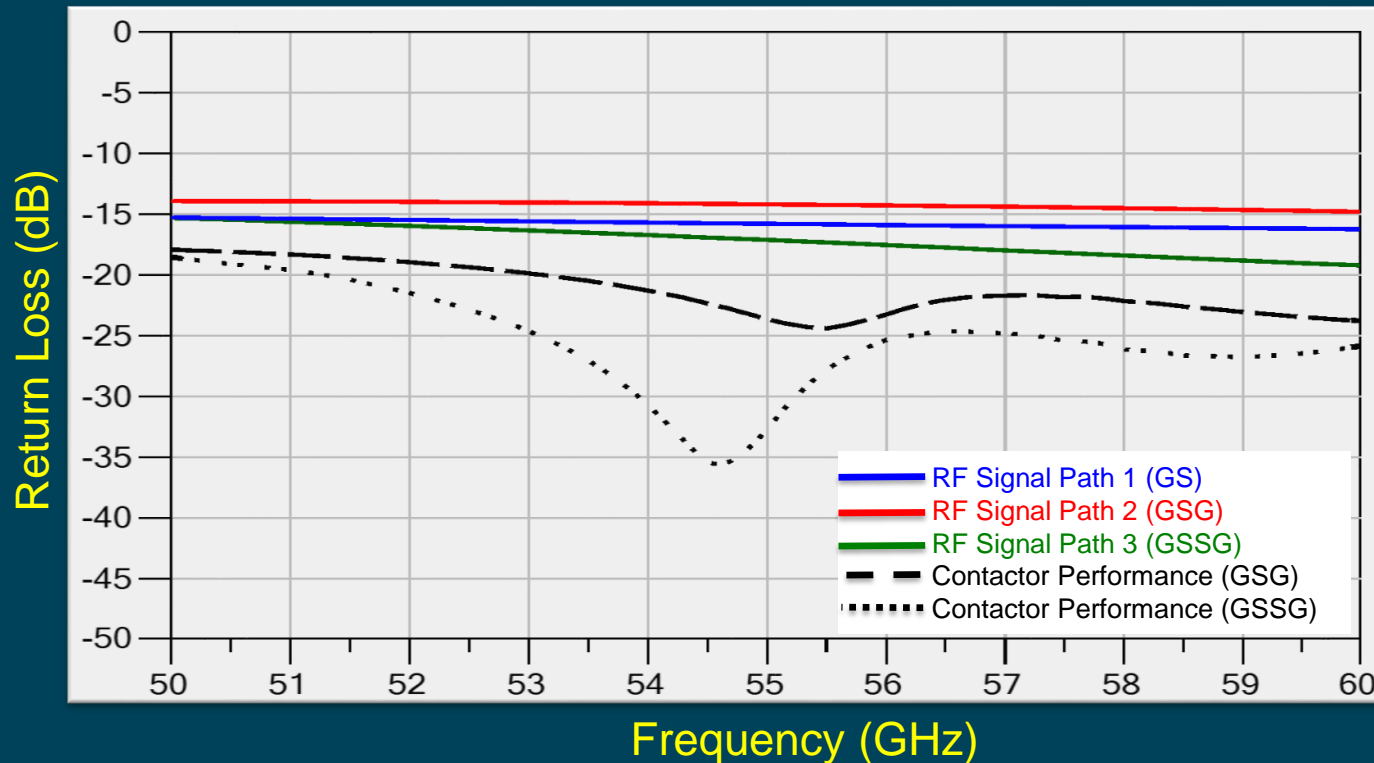
Modeled data includes loadboard and 50 Ohm interfaces

0.4mm Pitch IQtouch Micro Measured vs. Modeled (Edge vs. Center) – S_{21}



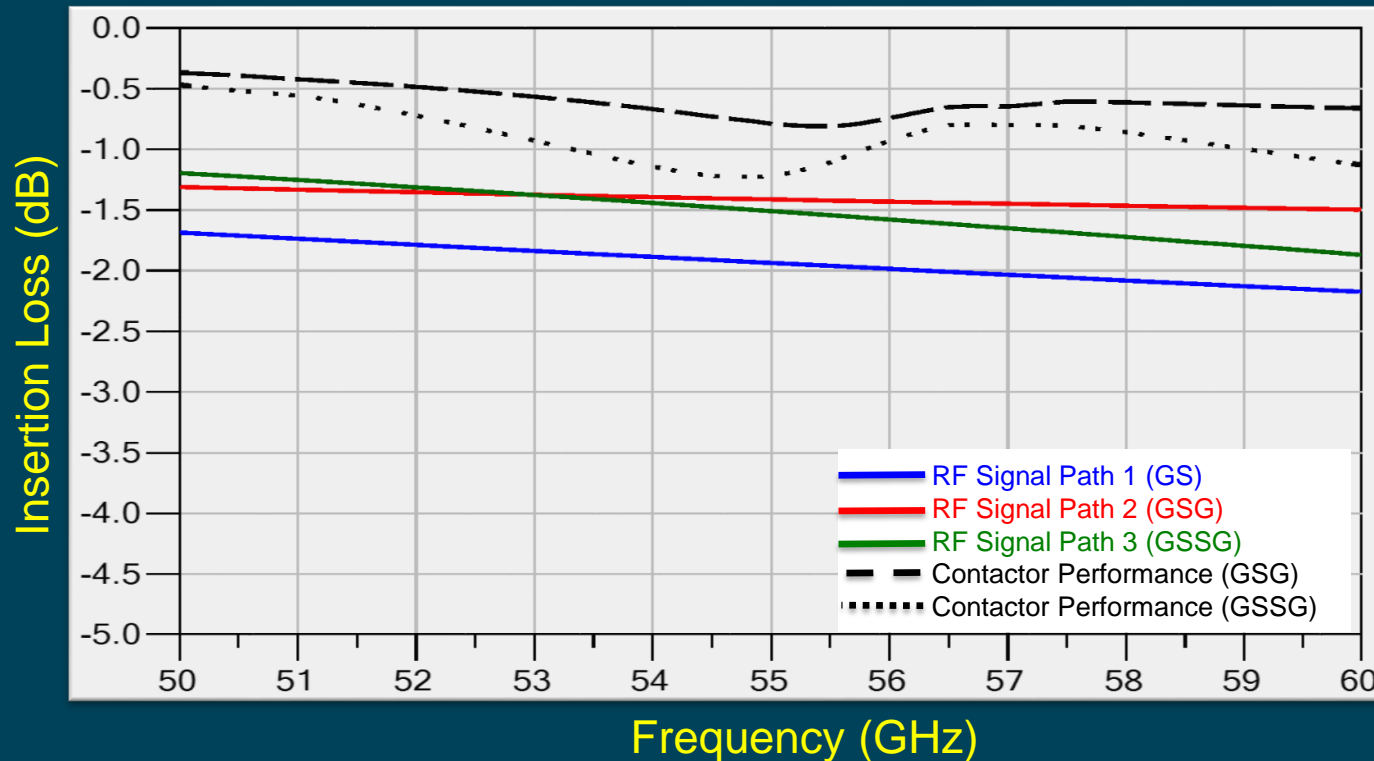
Measured data obtained by probing at top and bottom of contact

0.4 Pitch IQtouch™ Micro Contactor Performance – S_{11}



Contactor performance in the frequency of interest

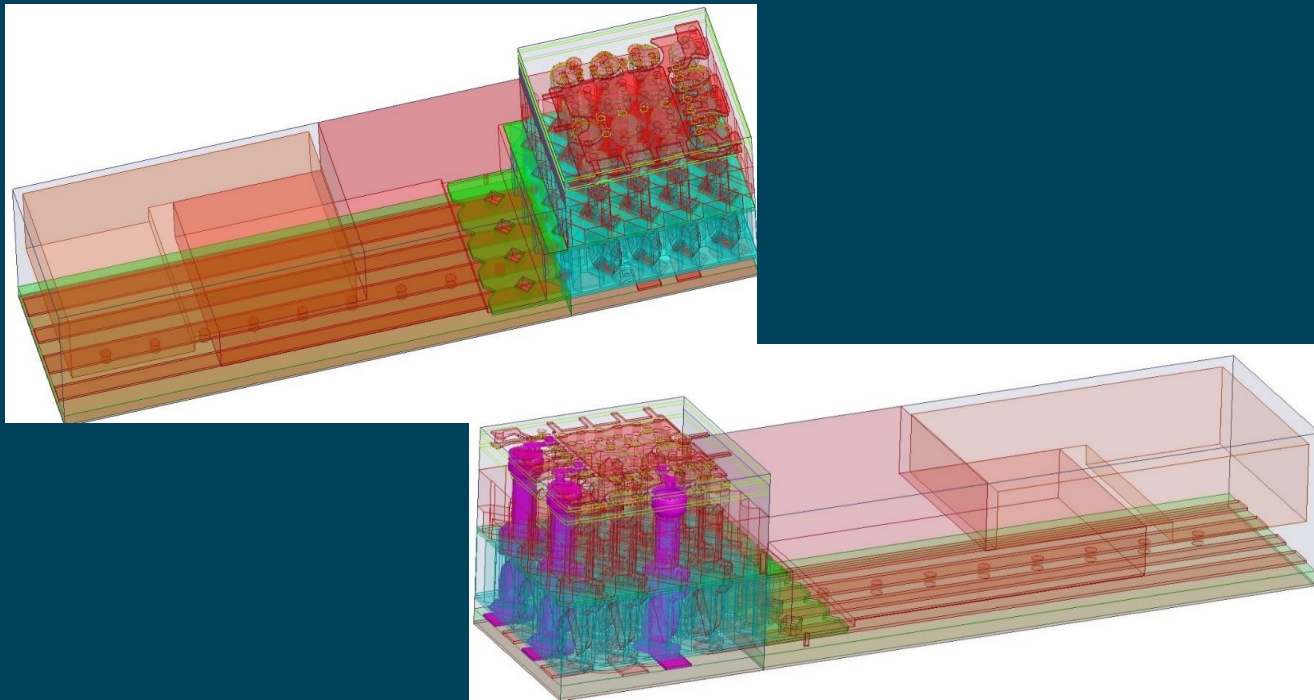
0.4 Pitch IQtouch™ Micro Contactor Performance – S_{21}



Contactor performance should exceed device's

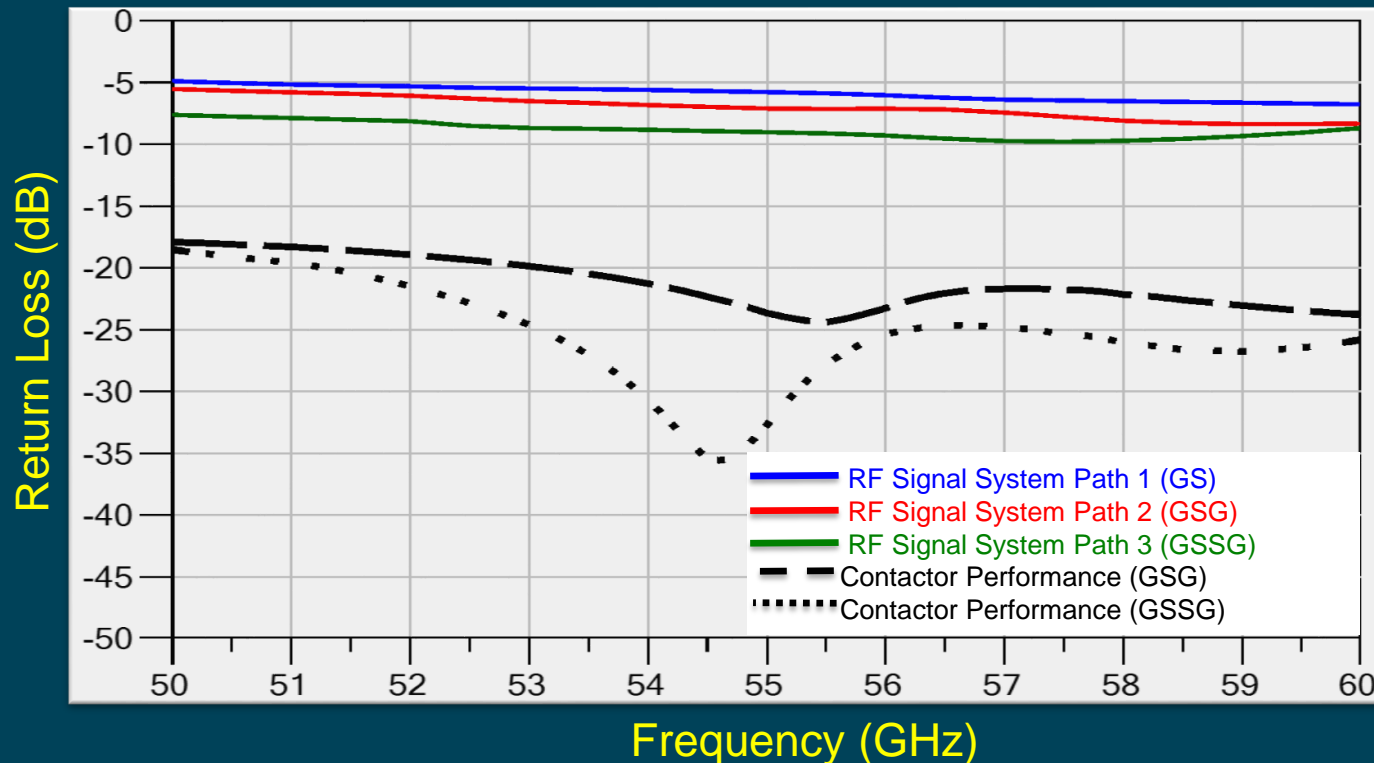
System Performance

Testing Needs a System Approach That Starts Early in the Design Phase



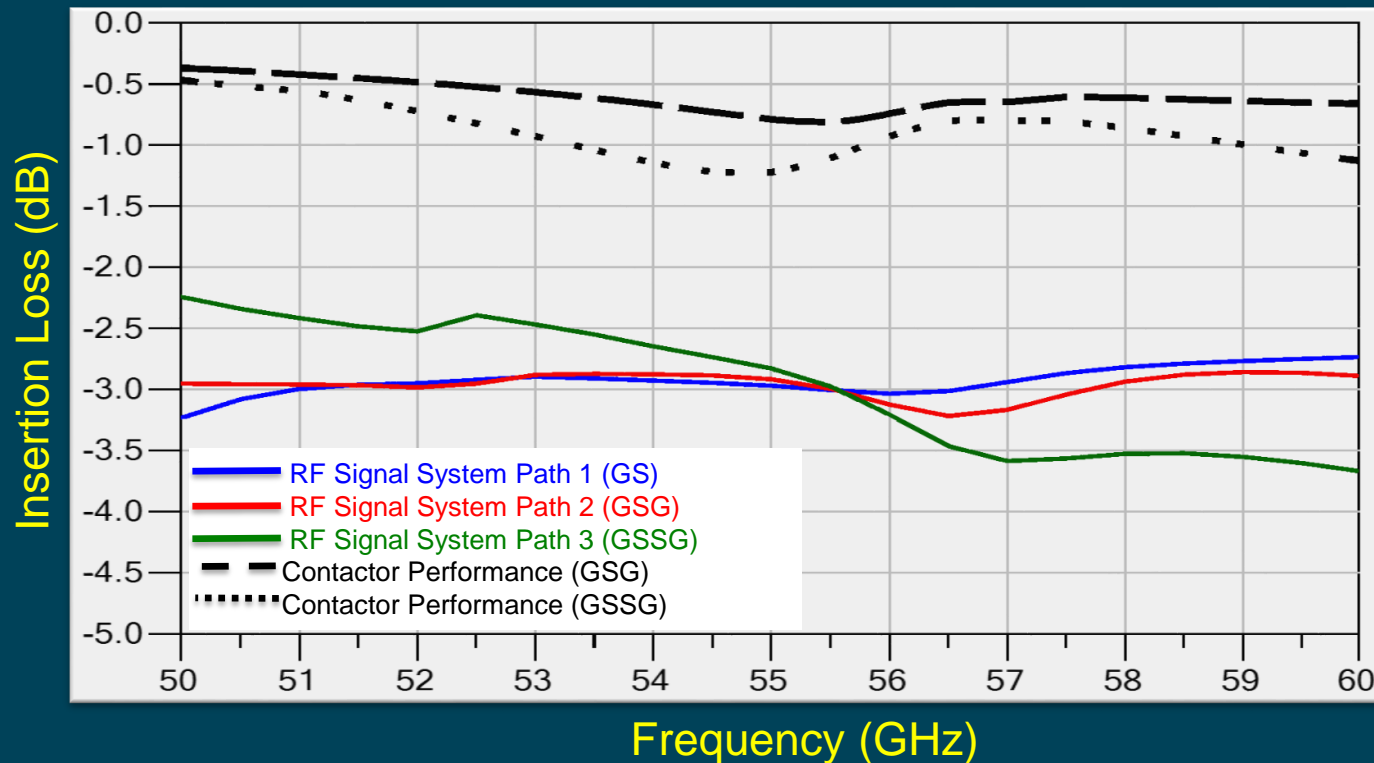
Material proximity to traces impacts trace impedance

0.4mm Pitch IQtouch™ Contactor With Package and Load Board Interface – S_{11}



Loadboard features have a significant impact on RF performance

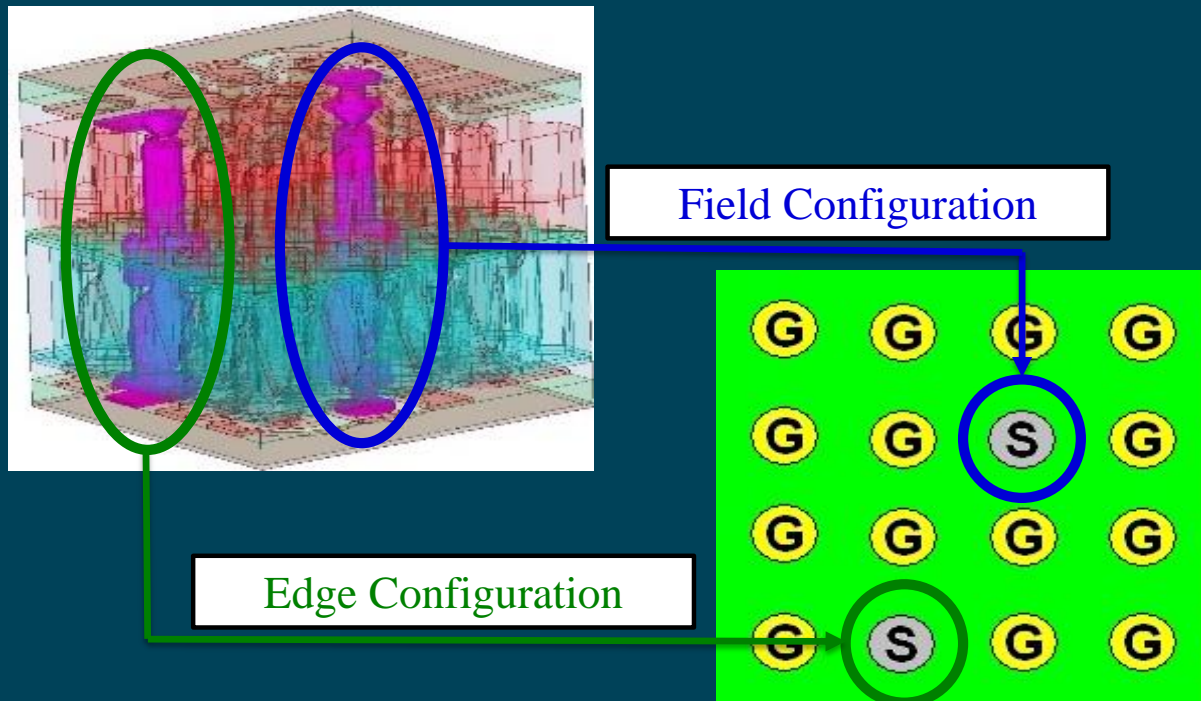
0.4mm Pitch IQtouch™ Contactor With Package and Load Board Interface – S_{21}



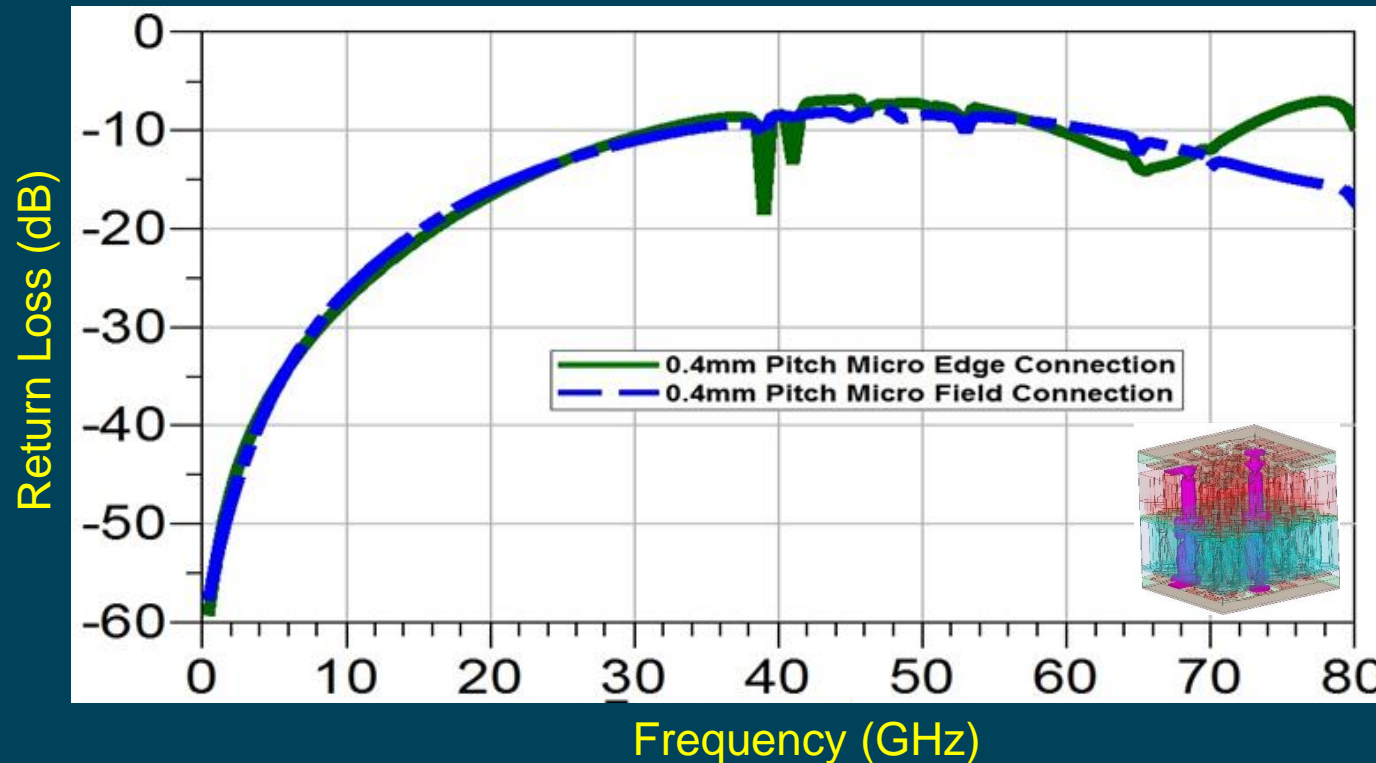
Long traces degrade signal integrity and lower BW

Edge vs Field Performance of 0.4mm Pitch IQtouch™ Micro Contactor

0.4mm Pitch IQtouch™ Micro Comparison of Edge vs. Field Configurations

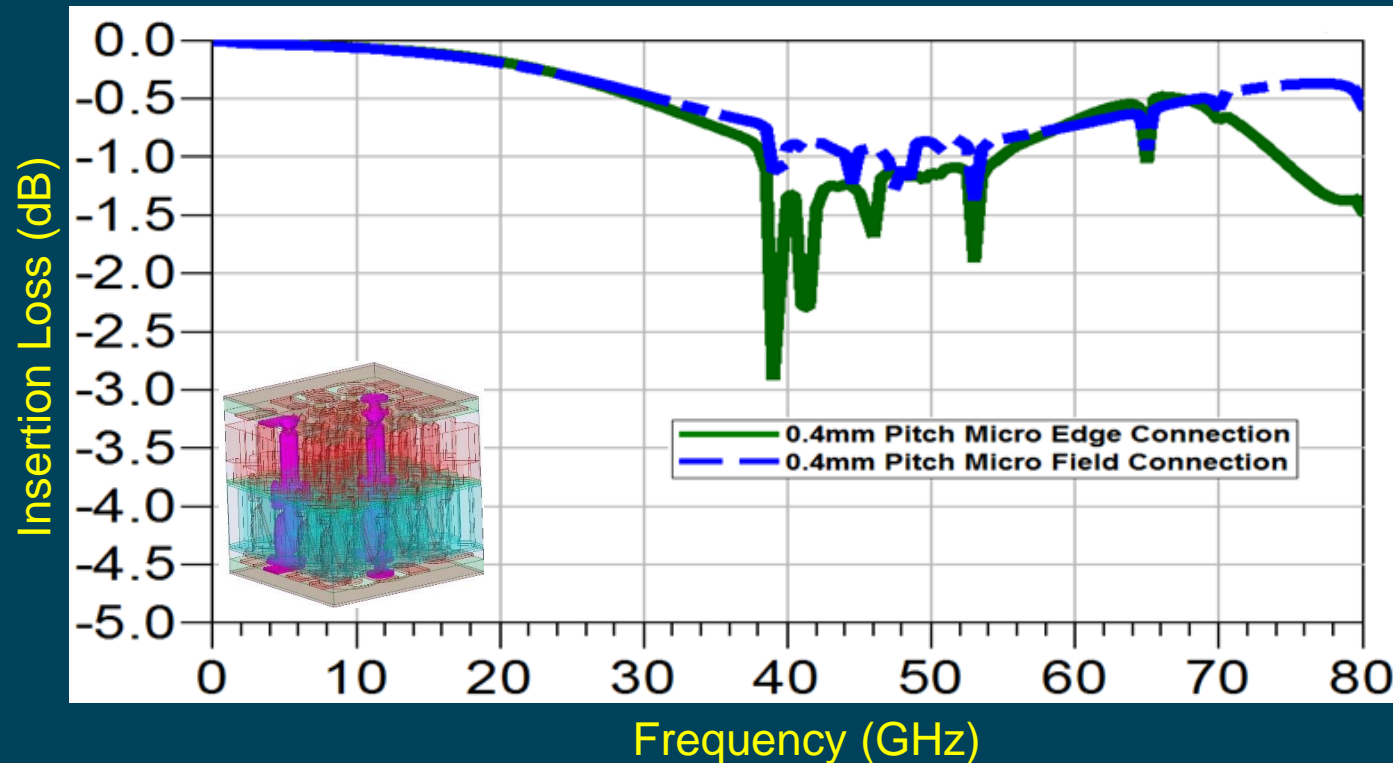


0.4mm Pitch IQtouch™ Micro Comparison of Edge vs. Field Configurations – S_{11}



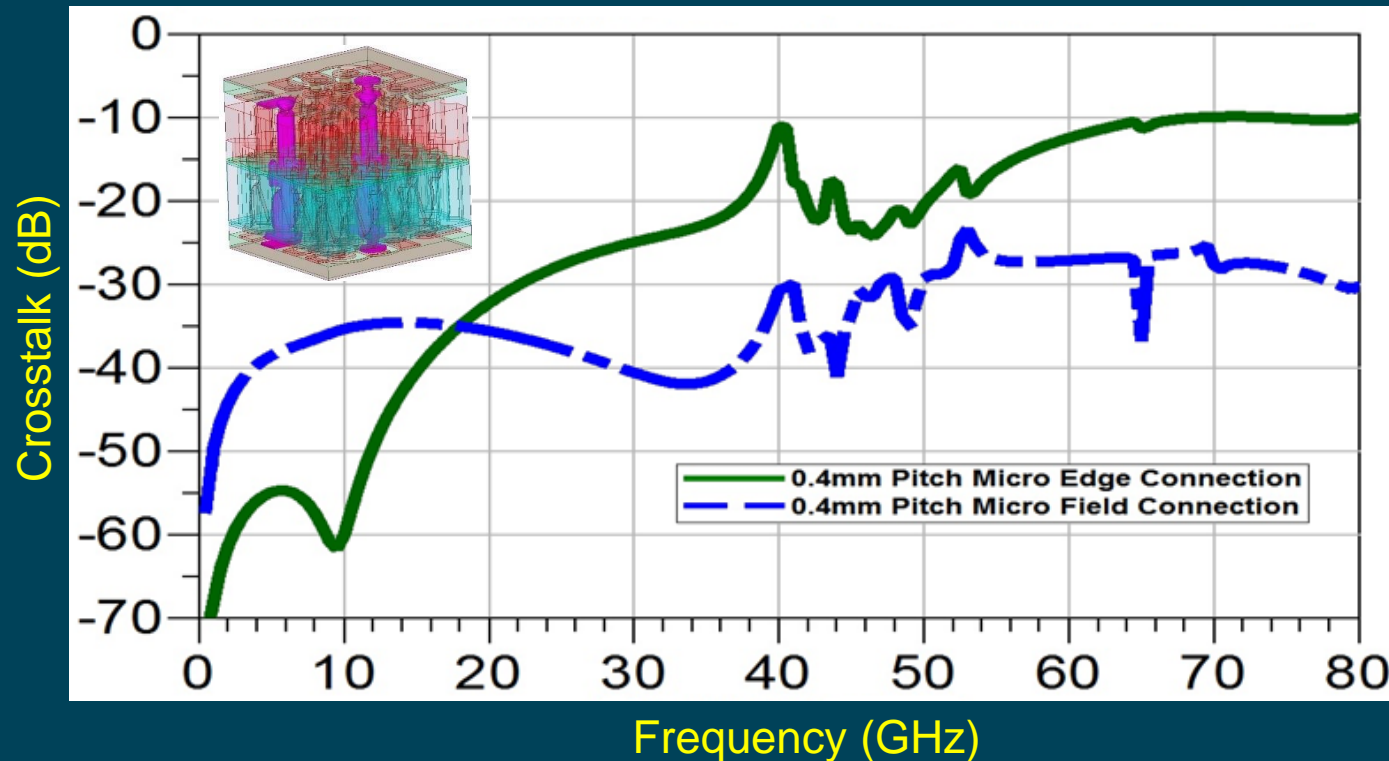
Impedance mismatches impact edge more than field connections

0.4mm Pitch IQtouch™ Micro Comparison of Edge vs. Field Configurations – S_{21}



Higher RF signals prefer short and direct paths

0.4mm Pitch IQtouch™ Micro Comparison of Edge vs. Field Configurations – S_{41}



Field connections have more noise immunity

Summary

- Parameters that affect device performance:
 - Grounding with respect to RF I/Os
 - Ball sizes
 - Stubs
 - Ball Pitch
 - Path lengths (wire bonds, vias, trace lengths etc.)
- Crucial properties of high frequency contactor:
 - Impedance matched to device
 - Lower return loss and higher bandwidth than device
- Continue collaboration of system components for millimeter wavelength test systems
 - System nuances have increasingly significant importance at higher bands