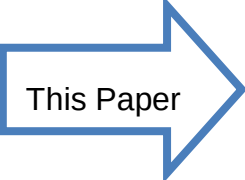


Tuesday 3/11/14 1:30pm

SOCKETS WITH INTEGRITY

High frequency signal and power integrity with sockets are essential to successful package testing. The opening presenter shares first-hand experience pairing the design of a high-speed load board with sockets of the desired bandwidth to avoid significantly reduced system performance. The second paper assesses power and ground performance through an examination of signal and power routings and the corresponding ground return paths for a PCB/socket combination. The next presenter looks at how ever shrinking devices with more functionality and higher density I/Os bring sensitive signal lines closer together, contributing to signal integrity issues. The paper closing this session discusses the impact on test hardware with the high-speed digital device world's leap to 28 Gbps Serdes. The presenter will describe what worked at 10 Gbps, what still works for 28 Gbps, and what might be changed and/or optimized to reach test speeds of 28 Gbps.



This Paper

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

Don Thompson—R&D Altanova

Signal and Power Integrity Impact of Ground Slugs in Sockets

Gert Hohenwarter—GateWave Northern, Inc.

Building Blocks and Predictors for Good Contactor Signal Integrity

Jeff Sherry—Johnstech International

COPYRIGHT NOTICE

The paper(s) in this publication comprise the Proceedings of the 2014 BiTS Workshop. The content reflects the opinion of the authors and their respective companies. They are reproduced here as they were presented at the 2014 BiTS Workshop. This version of the papers may differ from the version that was distributed in hardcopy & softcopy form at the 2014 BiTS Workshop. The inclusion of the papers in this publication does not constitute an endorsement by BiTS Workshop, LLC or the workshop's sponsors.

There is NO copyright protection claimed on the presentation content by BiTS Workshop, LLC. (Occasionally a Tutorial and/or TechTalk may be copyrighted by the author). However, each presentation is the work of the authors and their respective companies: as such, it is strongly encouraged that any use reflect proper acknowledgement to the appropriate source. Any questions regarding the use of any materials presented should be directed to the author(s) or their companies.

The BiTS logo and 'Burn-in & Test Strategies Workshop' are trademarks of BiTS Workshop, LLC. All rights reserved.

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

Don Thompson
R&D ALTANOVA



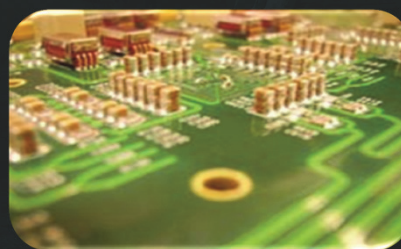
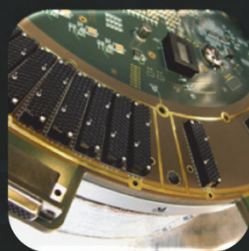
2014 BiTS Workshop
March 9 - 12, 2014



The Story:

While designing a high speed SERDES test circuit, we discovered the most limiting part of the design was not the load board, but the socket

This is a story that shows the importance of good socket performance in a design and dives into understanding the signal integrity aspects of socket design



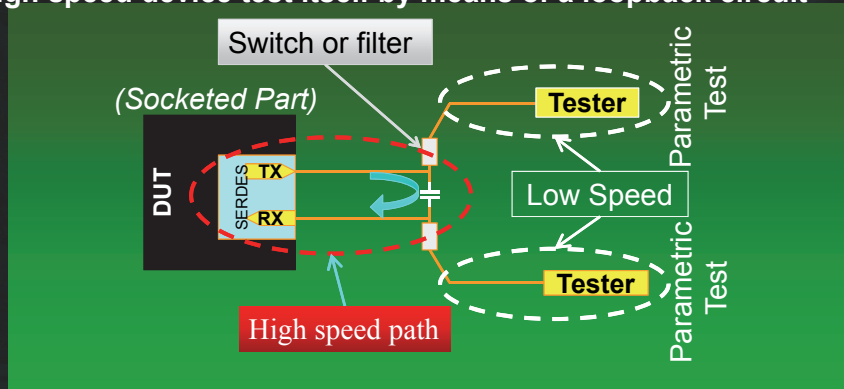
BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

2

Typical SERDES Test Circuit

Loopback Circuit – Testers can not economically go up to the speeds of today's high speed SERDES, so it is typical to have a high speed device test itself by means of a loopback circuit



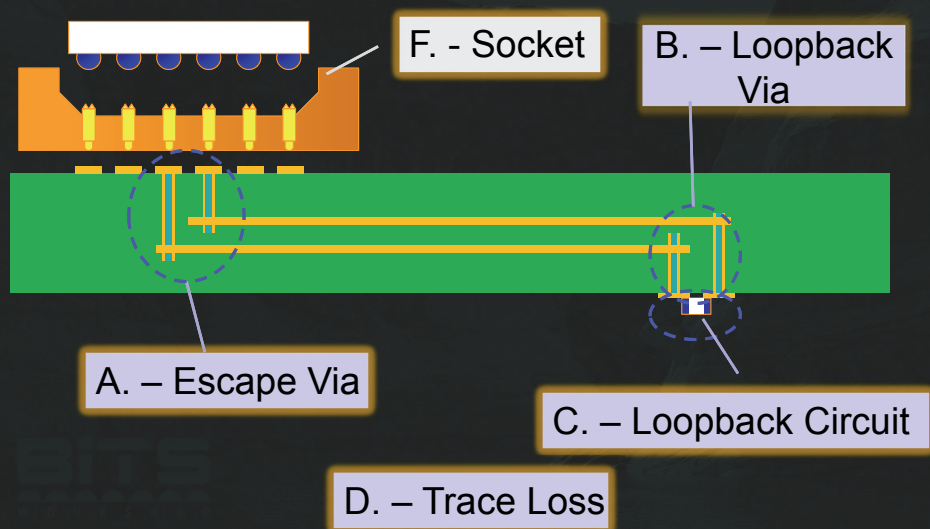
Load Board speeds for SERDES Channels are now often 28Gbps

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

3

SI Challenges To The SERDES Design



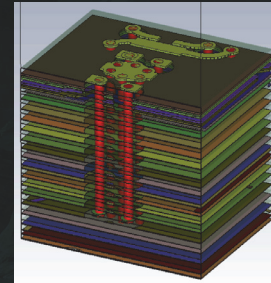
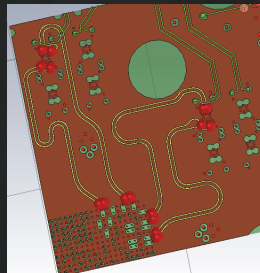
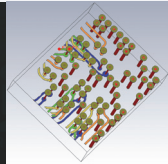
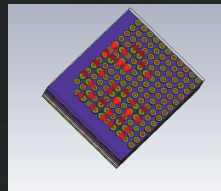
BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

4

Modeling Snapshot

- Modeling as broken up into different parts, DUT Escape, Trace, and Loopback



BiTS 2014

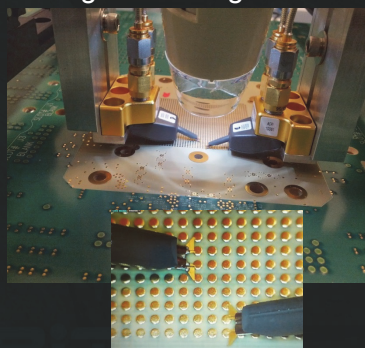
High Bandwidth Sockets For SERDES Applications On ATE Load Boards

5

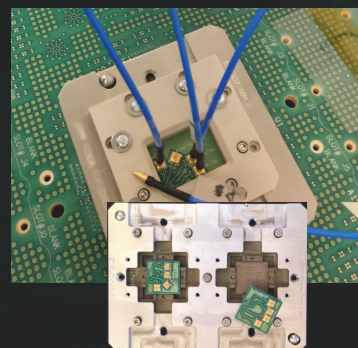
Validating The Design

Once the design is completed we need to verify performance. Using a VNA we have two different methods of measuring the performance of the board:

1. Micropositioner Probe
2. Surrogate Package



*Micropositioner Probe
(measures Board only)*



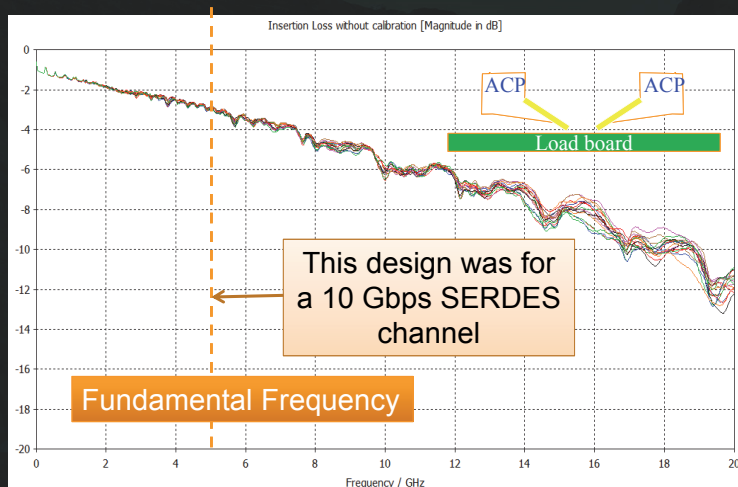
*Surrogate Package
(measures Board + Socket)*

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

6

Board Differential Insertion Loss (S_{dd21})



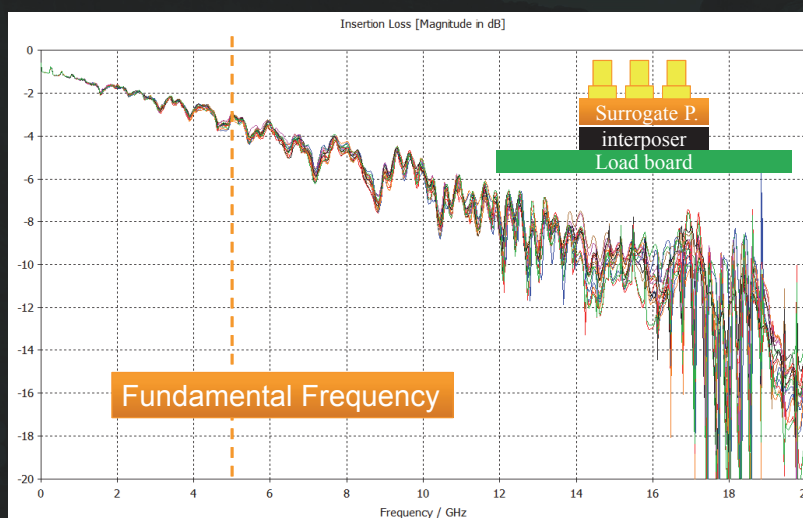
(16 Loopback Channels Measured using Micropositioner)

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

7

Board + Socket Differential Insertion Loss (S_{dd21})

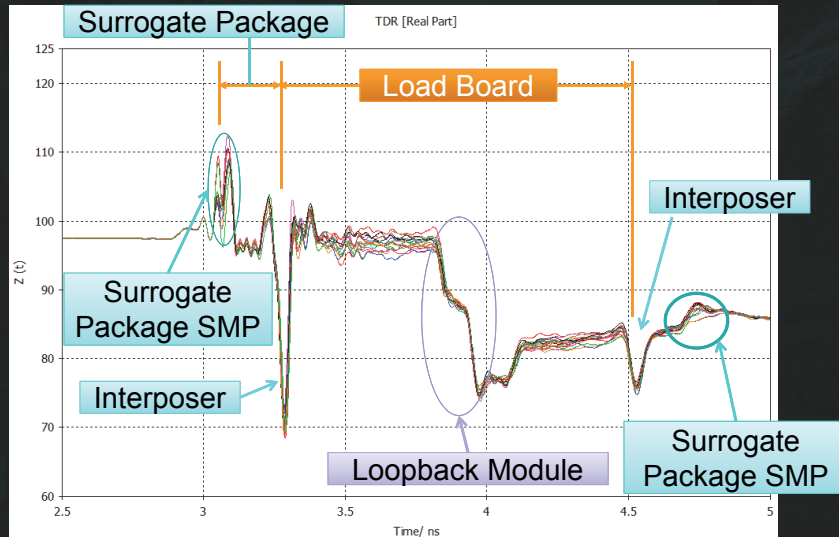


BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

8

TDR from Surrogate Package



BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

9

Analysis

- Interposer capacitance causes significant ripples in insertion loss due to its capacitance

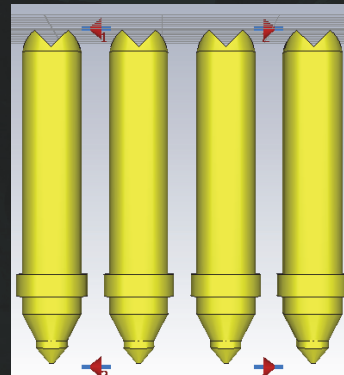
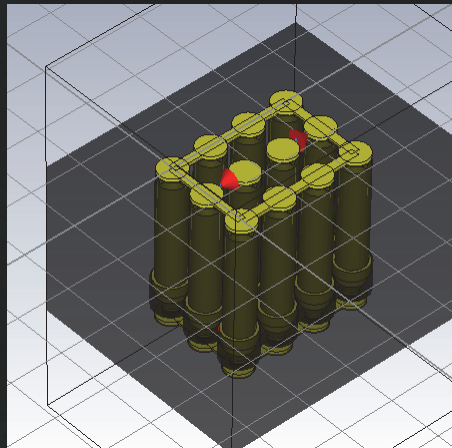
Let's figure out why the socket is causing problems!

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

10

Initial Design: 1mm Pitch Interposer



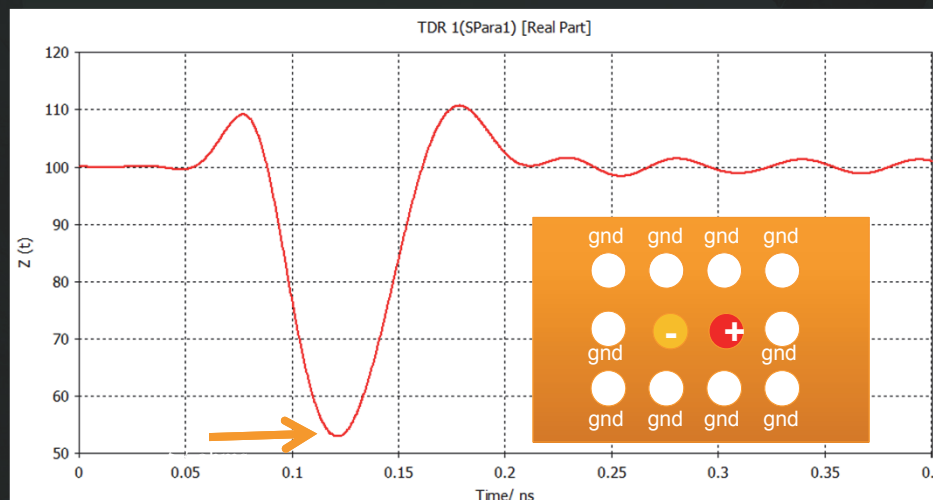
Simulated in Compressed State

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

11

Differential TDR (Simulated)



It's confirmed that the basic design of the socket is causing our impedance problems! We need a new interposer!

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

12

HOW TO GET A 100 OHM INTERPOSER

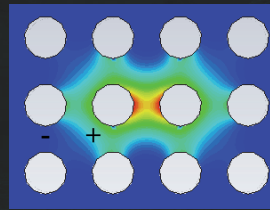
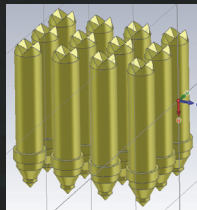
BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

13

Interposer Impedance Explained

- ① Impedance = $\sqrt{\frac{\text{Inductance}}{\text{Capacitance}}}$
- ② Inductance is a function of the pin diameter (inversely proportional)
- ③ Capacitance is a function of ground metal to signal metal AND dielectric material (*Combination of pitch, pin diameter, and dielectric material*)



Differential
impedance in
a pin field

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

14

Impedance “Tuning” Design Tools

IN A TYPICAL DESIGN:

We can't change:

- Pin Pitch
- Pin out

We can change:

- Pin Diameter (By selecting an alternate pin)
- Dielectric Material of socket

Therefore

If Too Capacitive

- ↓ Reduce Pin Diameter
- ↓ Reduce Dielectric Constant (Er)

If Too Inductive

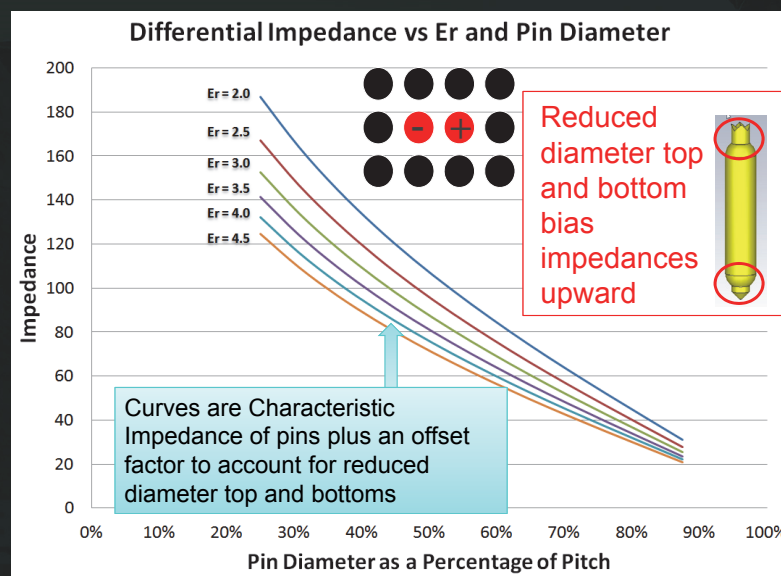
- ↑ Increase Pin Diameter
- ↑ Increase Dielectric Constant (Er)

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

15

Spring Pin Differential Impedance Chart

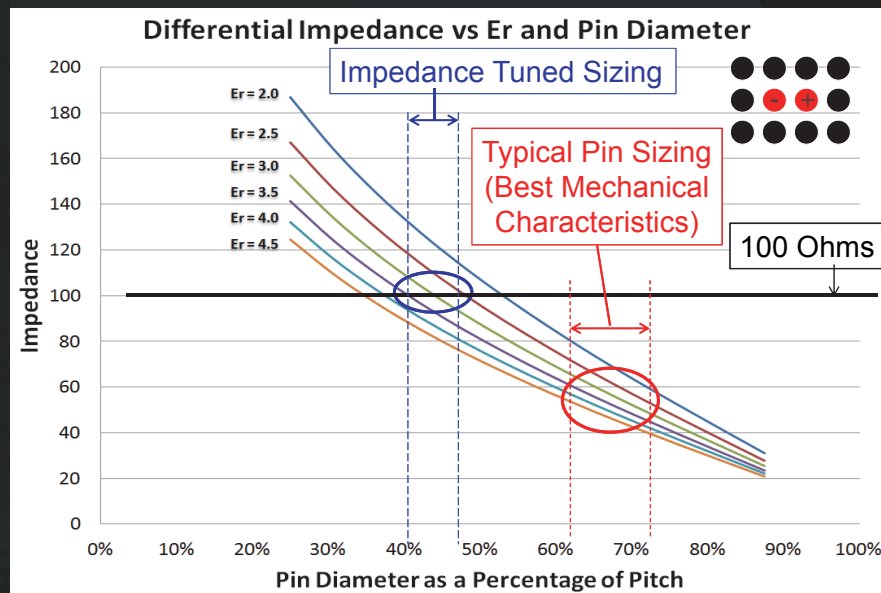


BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

16

Spring Pin Diff Impedance Tuning



BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

17

Caveats

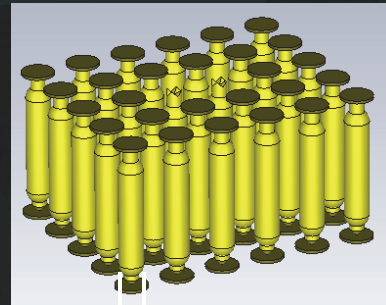
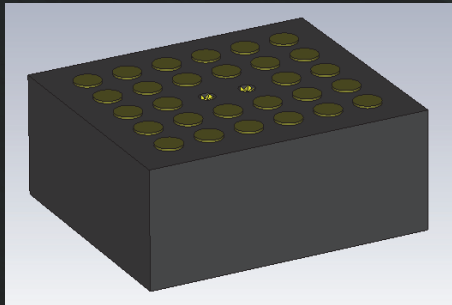
- Analysis shown is good to a 1st order approximation. Actual sockets will vary depending on air cavities, geometric nuances, etc. For best results use a 3D field solver.
- Air cavities will affect your dielectric constant. If you have significant air cavities average the dielectric constant of air ($\epsilon_r=1$) with the volume of dielectric to determine your socket equivalent dielectric to use the chart.
- When selecting your socket you **MUST** take into account other design requirements and they must be balanced against your high performance needs. (Low inductance pins for power, crosstalk requirements, etc.)

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

18

Select An Alternate Pin To Use



Select a pin diameter that's 40% pitch

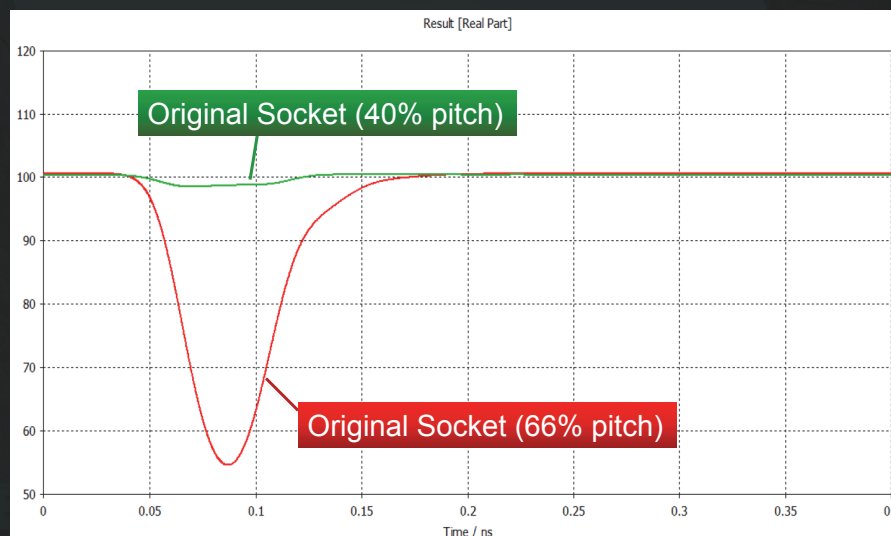
And simulate results....

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

19

TDR Simulated

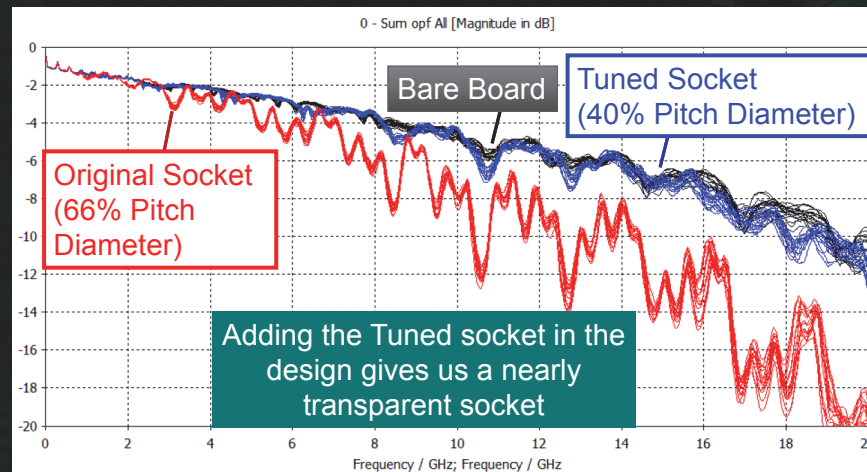


BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

20

Factoring This Back Into The Design



BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

21

Conclusions

- Sockets must be included in ATE channel performance solutions
- Standard spring pin sockets can be tuned to work at high speeds at the cost of mechanical metrics and electrical metrics (manufacturability, reliability, cycle life, and pin cost)
- Bandwidth is a function of pitch, pin size, and your dielectric material

BiTS 2014

High Bandwidth Sockets For SERDES Applications On ATE Load Boards

22