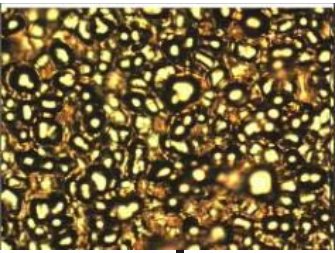




Giga Connections, Inc. is a licensed manufacturer that works closely with circuit board houses to Diamond Plate (DP) FR4, Flex and Kapton substrates for 3<sup>rd</sup> party designs. The Conductive Diamond Plating forms an electrical interconnect that demonstrates an ~1% impedance discontinuity, similar to a soldered junction, without any observable inductance or capacitance, thereby achieving a connection bandwidth beyond 40 GHz.

Giga Connections Inc. has successfully developed 40 GHz DP Interposers for Device Test Sockets used in 10 G/bit communication systems and radiation device testing. Other applications include the plating of Flex circuit contact pads used in VLSI test-head connectors and instrument test probes.

Giga Connections, inc  
4182 Center Park Dr.  
Colorado Springs, CO 80916  
[www.gigaconnections.com](http://www.gigaconnections.com)



# Conductive Diamond Plating (CDP) Description

- The CDP interposer uses conductive diamond particles to form a superior, multi-point connection system. The CDP surface pierces any contaminants on either the DUT leads or test contacts. The resulting contact resistance is fewer than 5 milliohms with no measurable inductance or capacitance after thousands of mate/demate cycles. The controlled impedance material is electrically invisible, requires as little as 10-15 grams contact force, and resists oil and dirt contaminates.
- CDP has been used in military systems, including super computers and satellites meeting all military environmental specifications. CDP enables 10 – 40+ G/bit devices to perform the same or better within socket applications than if they were soldered directly to the board, thereby opening opportunities for a new lead- free interconnect technology.





# Conductive Diamond Pin-less Interposer™ Specifications

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Slides 4-10 describe the GCI Pin-Less Interposer™ mechanical and electrical specifications.

GCI takes care to use proven test methods to describe the Pin-Less Interposer™ electrical bandwidth performance. A specification is not always accurate in every application because most socket interposers are very small and difficult to measure. De-embedding the test fixture can produce performance difference from a electrical specification.

The problem occurs when a bandwidth mismatched interposer is placed in a distributed L/C network (i.e. test board or system) un-predictable signal integrity anomalies can and do occur. For this reason, GCI provides several measurement modalities to verify the 40 Ghz or 14ps rise time bandwidth specified for the GCI Pin-Less Interposer™ as an accurate stand alone interposer when placed in an active system.

Measurements modalities include: SPICE simulation, Return loss analysis based on an active terminated device, L/C discontinuity (impedance) measurements that correlate with return loss measurements on an active 10G/bit test board, Insertion loss using a 100ps, 6.25 G/bit Functional Test compliance eye diagram, and a Vp-p plot showing that the Pin-Less Interposer™ does not resonate and that its signal integrity performance compares to a soldered junction.

# Summary of the Conductive Diamond Pin-less Interposer™ Specifications

## Electrical Specification

- > 40 GHz bandwidth / ~14ps rise time
- No measurable inductance or capacitance
- ~1 % increase in impedance measured at 10 G/bits data rate

## Interconnect Technology

- 4-20 um conductive diamonds
- Surface mount connector
- 10 micro-inches of gold plated final finish
- Contact point size is 10 um; 20 mil (0.5 mm) pitch can be achieved
- RoHs compliance - lead free
- ~25 mil mechanical stack up height

## Pin Density Count

- >2000

## Maintenance

- Surface can be refurbished
- Clean with ultrasound bath

## Reliability

- Hundreds of thousands of insertions without measurable degradation in signal integrity

## Force

- 15 - 30 Grams force per pad required to achieve electrical continuity

## Current Handling:

- ~15 amps per 10 mil (0.25 mm) diameter pad

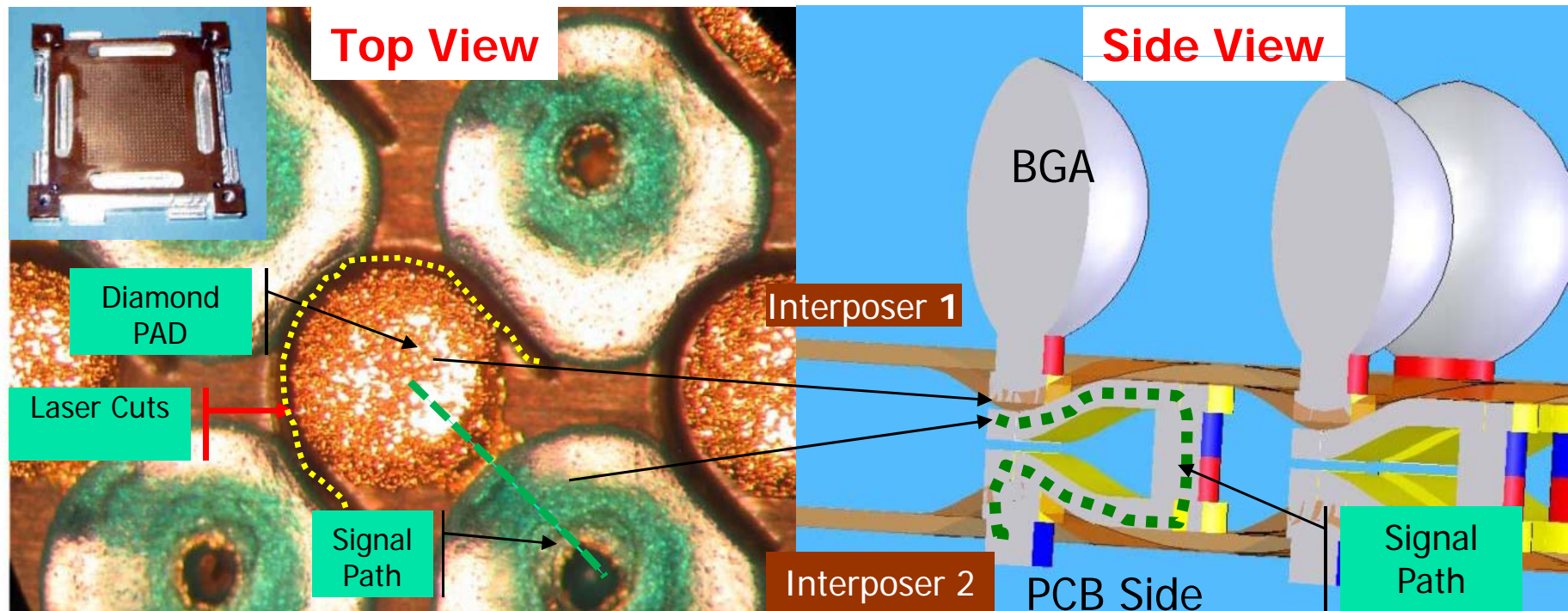
## Temperature Range

- 60C to 200C for Kapton film Interposer



# Achieving Mechanical Interposer Compliance and Signal Routing

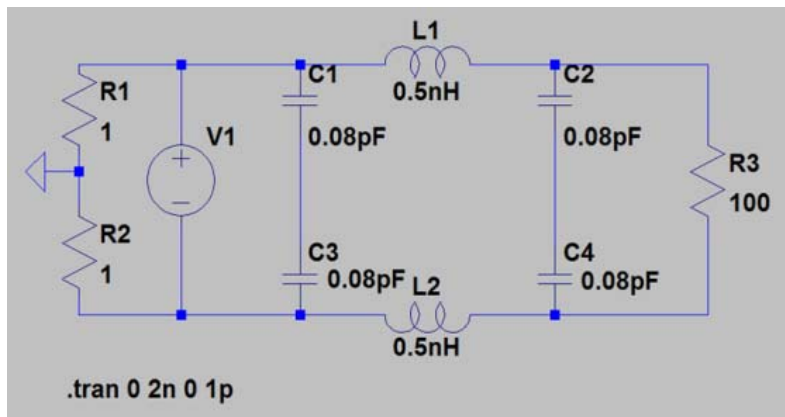
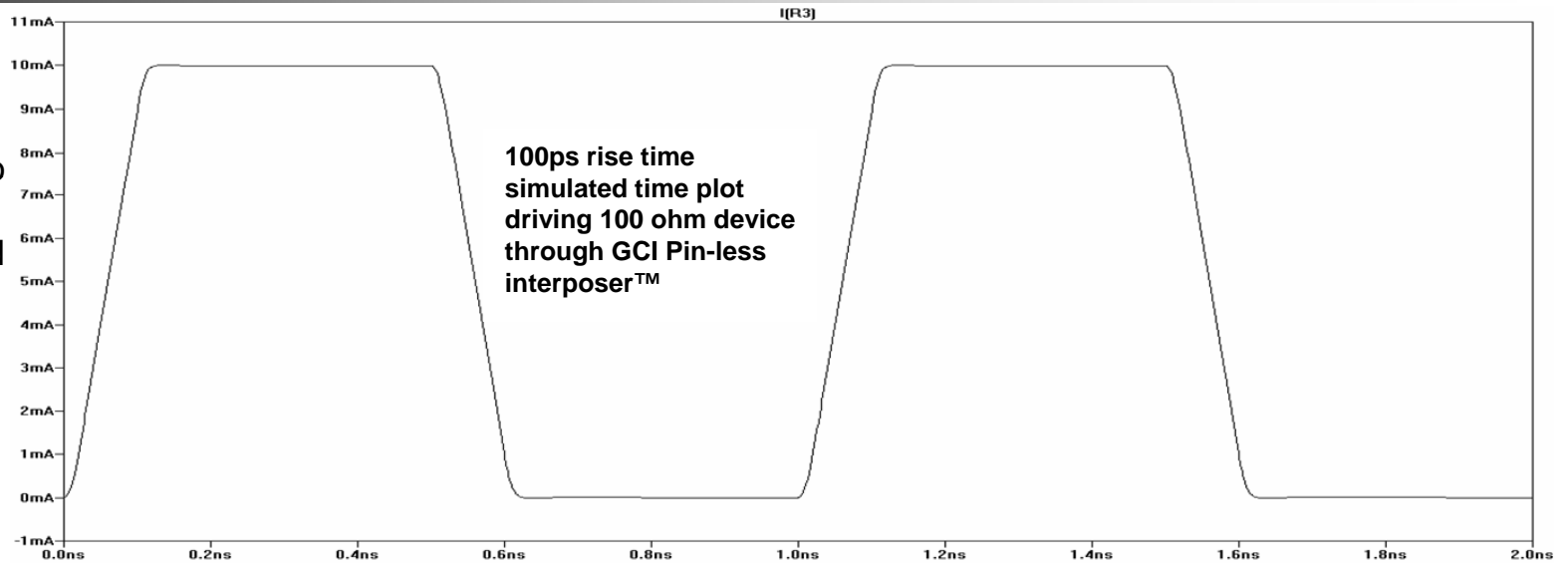
Two Interposers are stacked together to provide ~25 mil mechanical stack up height. Laser cutouts form a U around the diamond PAD and cantilever allowing pad to move independently to provide 4-8 mil compliance for each BGA ball without affecting signal integrity.



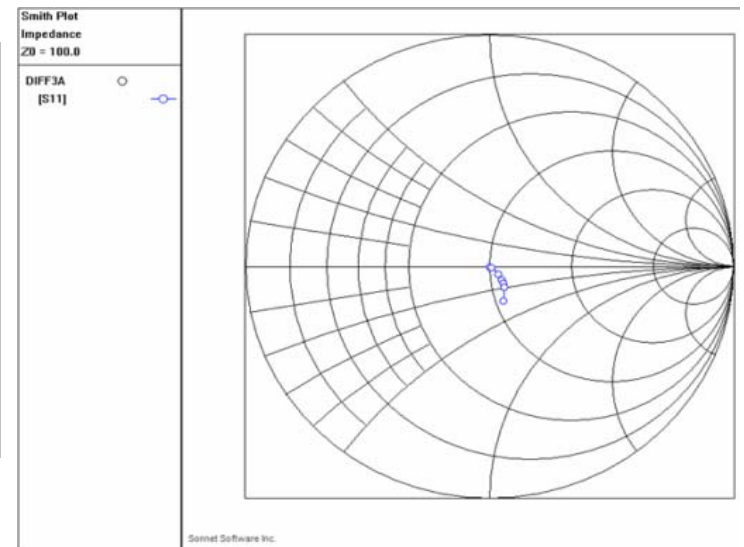
# GCI Pin-less Interposer™ SONNET SPICE Model

SONNET simulation of two signals, 100 ohm differentially with grounded pads on either side. The pitch between the two GCI interposer pads is 0.8mm. This model represents the interposer with an IC inserted and makes for a very good match to 30 GHz.

Model was limited to 30 GHz due to scaling accuracy of simulator. Time Domain waveform simulation compares nicely with measured waveforms.

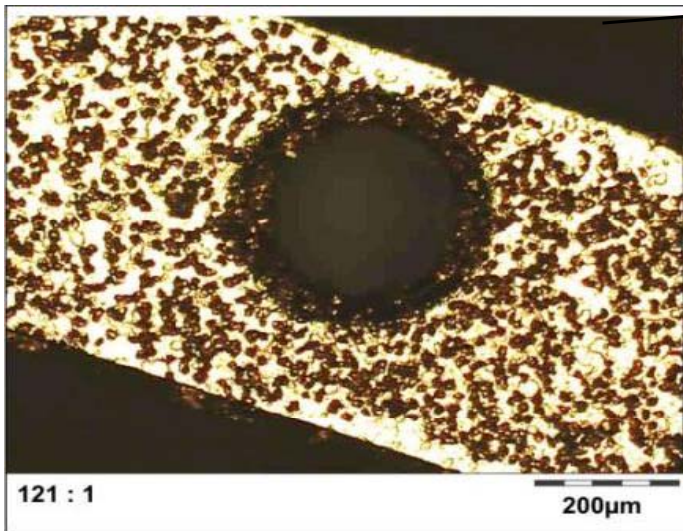


100 ohm SPICE circuit of a GCI interposer

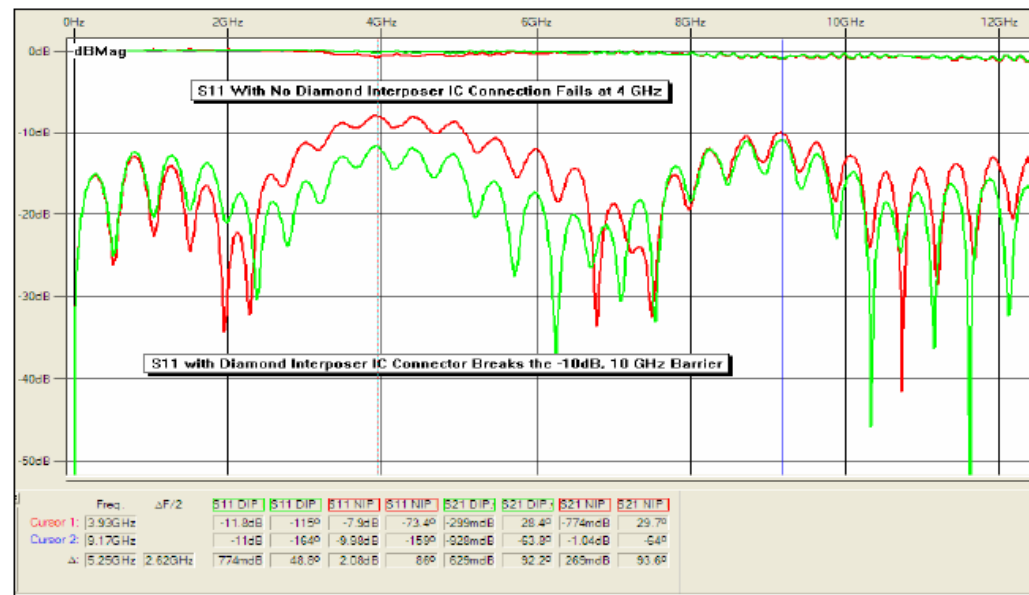
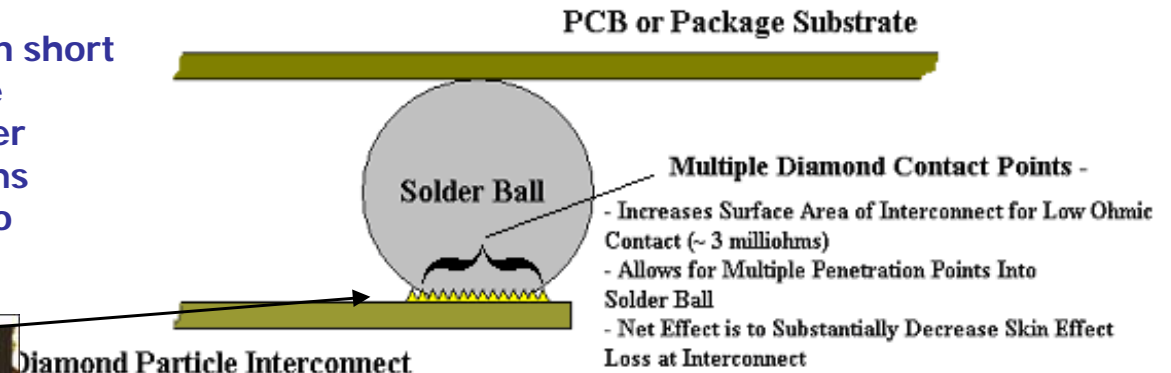


# Improves System Interconnect Return loss (S11)

The Pin-less interposer™ cantilever design short signal path contains very little observable inductance and capacitance. The cantilever 20mil length is closely matched to 50 ohms providing very little signal discontinuity to degrade system interconnect return loss.



SEM view of (CDP) Pad shows hundreds of diamond points- increase physical connection in lead free or hard surface to surface connections

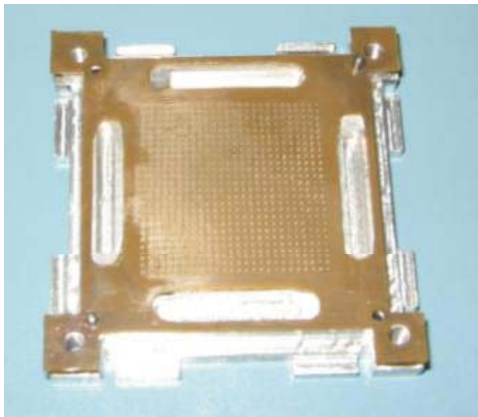


# GCI Pin-less Interposer™

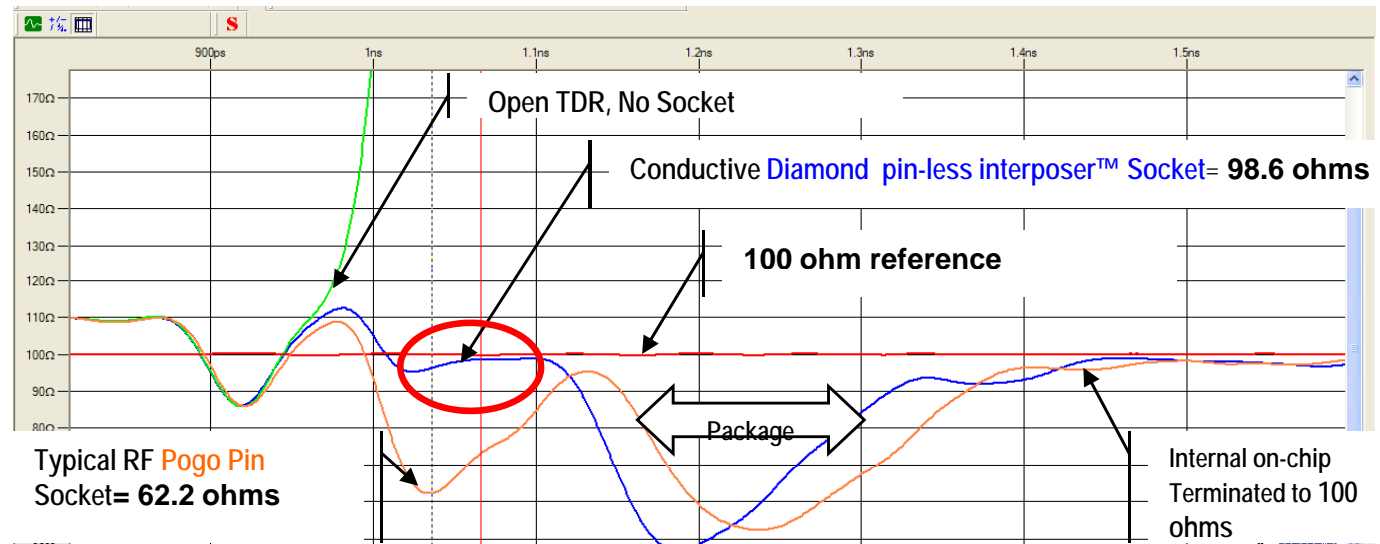
## Matched Impedance Design

### Reduce Return-Loss (S11) Degradation

Differential Impedance  
Measured: 98.4 ohms



676 BGA DP Interposer

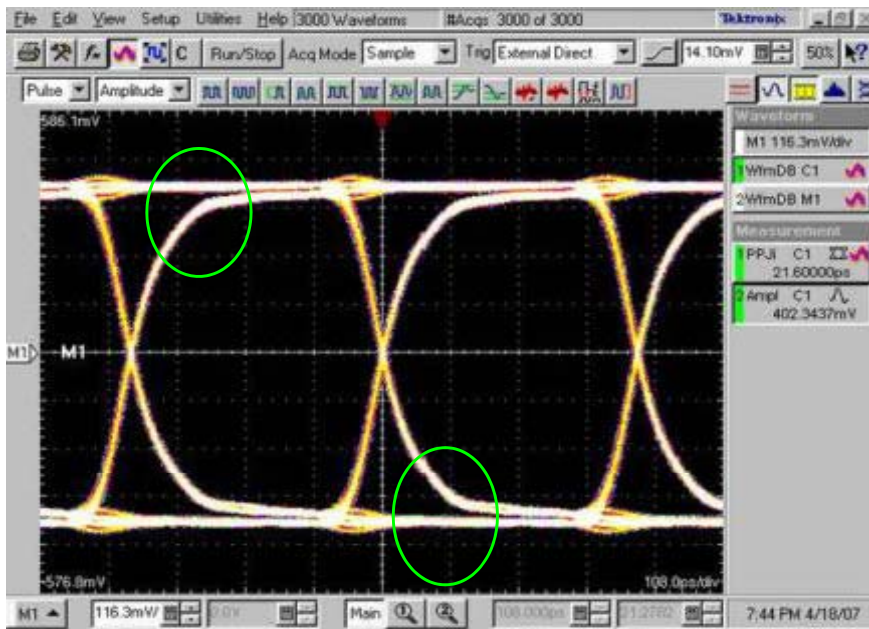


The Conductive Diamond Pin-less Interposer™ is a better match for the PCB and the transceiver IC onboard terminator. Most significantly, the CDP shows no capacitive or inductive reactance measured to 10gbit. With a uniform impedance profile, the Pin-Less Interposer™ improves the interconnect system Return Loss. A typical Pogo Pin interposer show a 40% impedance error.

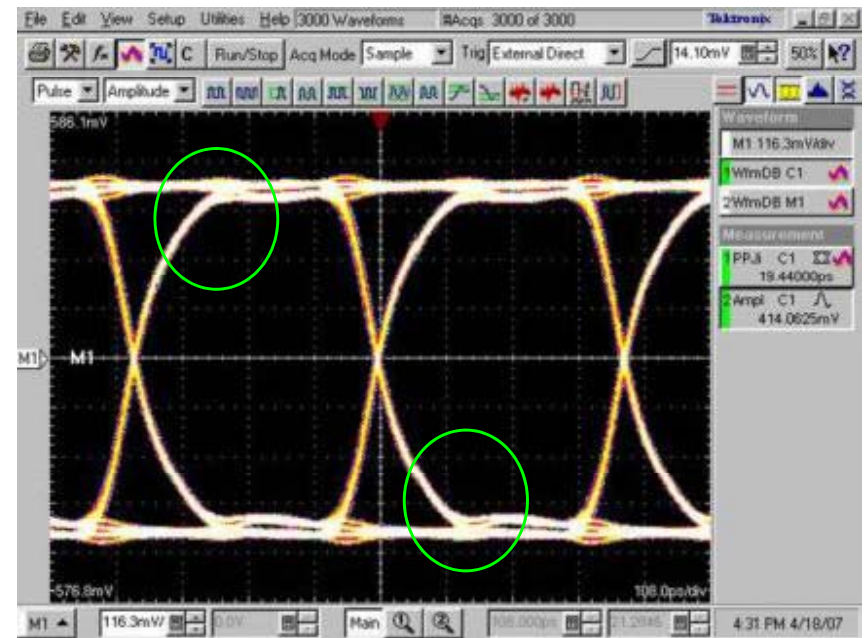
# Insertion Loss

## GCI Diamond Pin-less Interposer™ Near Zero Insertion Loss at 6.25G/bit

The GCI Pin-Less Interposer™ 40GHz bandwidth has an equivalent ~9ps interconnect rise time. To demonstrate how this bandwidth improves a 6.25G/bit device driver eye diagram analysis, a active device was measured in a GCI Diamond Pin-less Interposer™ socket and from an equivalent bandwidth pogo pin socket. Notice the 6.25G/bit eye diagram does not roll off the 100ps rise time/fall time corners so the signal goes rail to rail providing a symmetrical eye diagram. The 40GHz bandwidth of the GCI Pin-Less interposer™ does not degrade the 5<sup>th</sup> to 7<sup>th</sup> harmonic so the 100ps Device Driver Rise time does not roll off indicative of a nearly zero insertion loss for this 6.25B/bit or 100ps rise time device driver. 50ps devices will get similar results



**DCI Pogo-Pin Socket RT & FT roll off  
Developing a non symmetrical eye at  
6.25G/bit**



**GCI Diamond Pin-Less Interposer™ Socket  
100ps RT & FT go rail to rail for a  
symmetrical eye at 6.25G/bit**

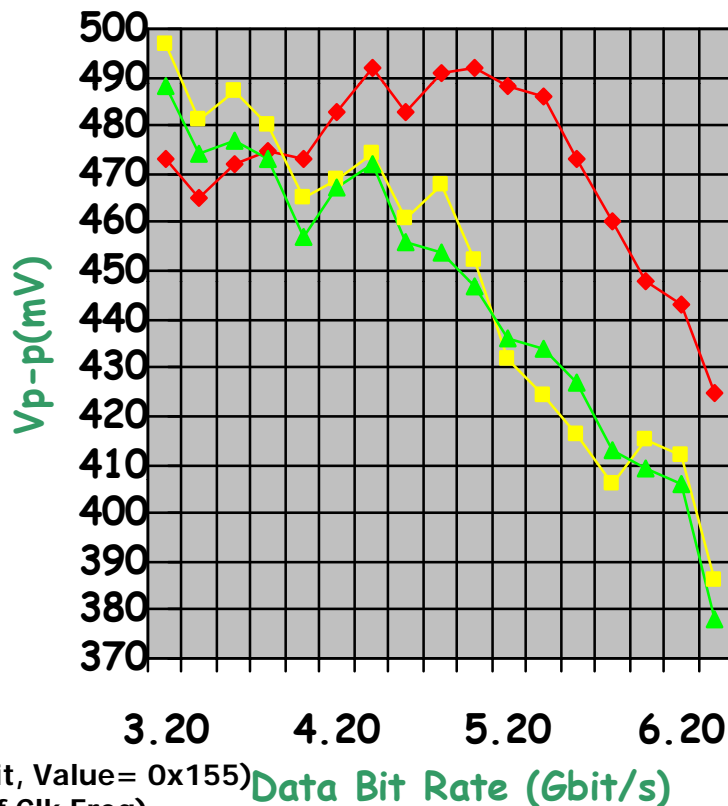
# System Test Demonstrates GCI Pin-less Interposer™ Bandwidth Represents Soldered Connection

EN6110, S/N 2, TXP Vswing

Vp-p Vs. Data Bit Rate



V<sub>p-p</sub> Data Bit Rate:  
3.2 Gbit/s – 6.4 Gbit/s



- Diamond Pin-less Interposer™ Closely Tracks Soldered device to 6.4G/Bits
- Pogo pin socket plot does not correlate with solder device (*real world*). Why?
- At low frequency, Vp-p plots low? Pogo Pins probably capacitive loads down signal
- At high frequency, Vp-p appears high? - L/C ringing (resonates) adds to signal creating false bandwidth reading
- Diamond Pin-less does not affect V<sub>p-p</sub> to provide symmetrical Eye Diagram



- 1) Pattern: 101010 (10 bit, Value= 0x155)
- 2) Bit Rate= 2 \* (10 \* Ref Clk Freq)
- 3) All Vpp data is in millivolts
- 4) PRBS 31
- 5) TX Outputs measured at SMA connectors
- 6) Soldered Part was different than S/N 2

# Applications for GCI Pin-Less Interposers™

Manual Test Sockets

**BGA, LGA , QFN, Etc.**

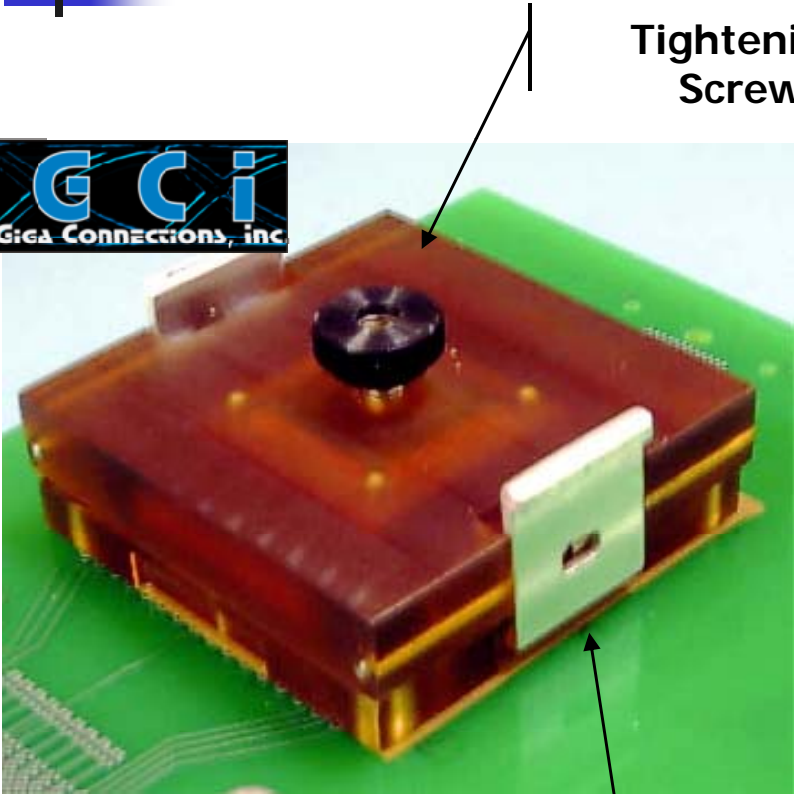
OEM Manufacture Socket

**Lead Free Prototype Design**

**Device Reuse for high speed  
(100ps) Manufactured board**

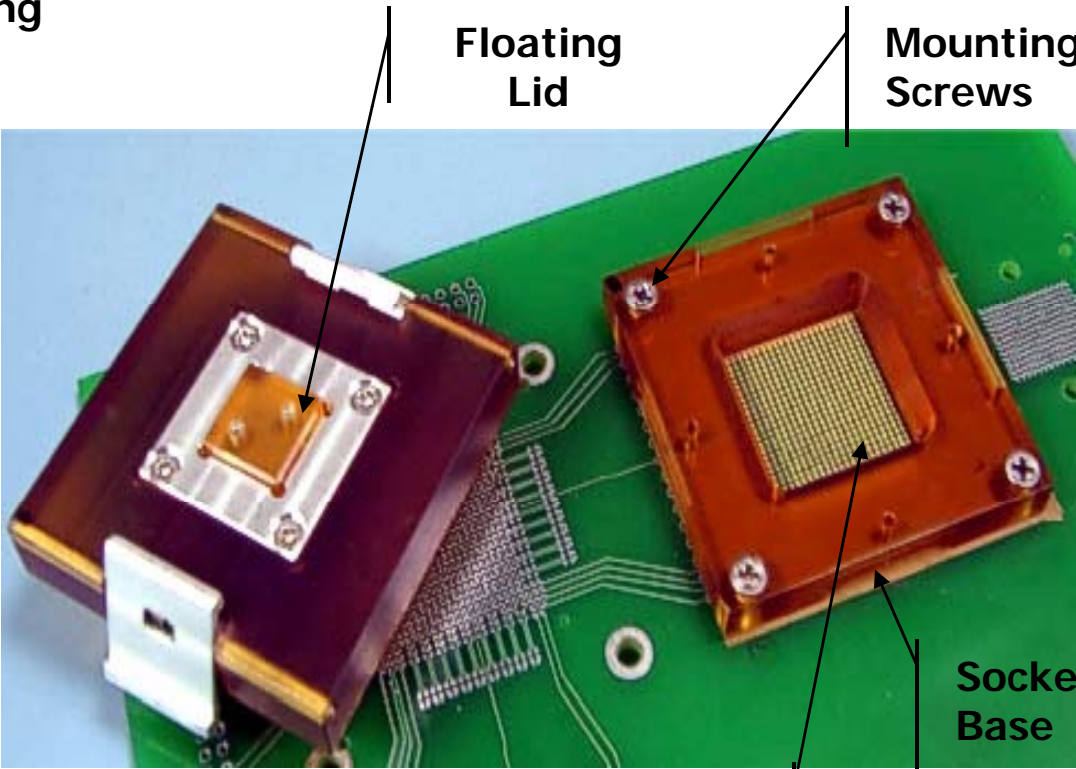
Board to Board Interposer Connector

# Conductive Diamond Pin-Less Interposer™ Test Socket Assembly



Tightening  
Screw

Side Clamps



Floating  
Lid

Mounting  
Screws

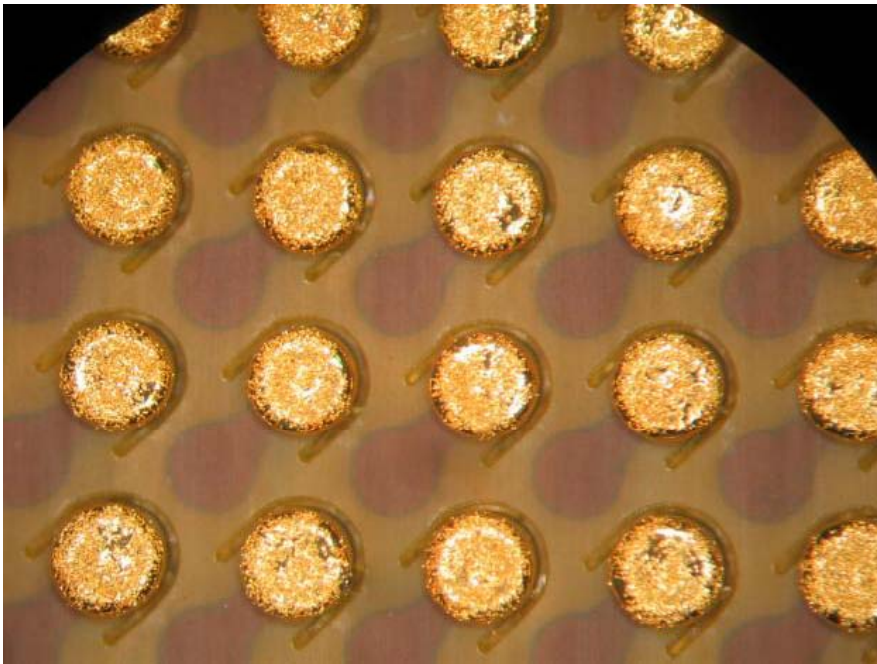
Socket  
Base

Conductive Diamond  
pin-less Interposer

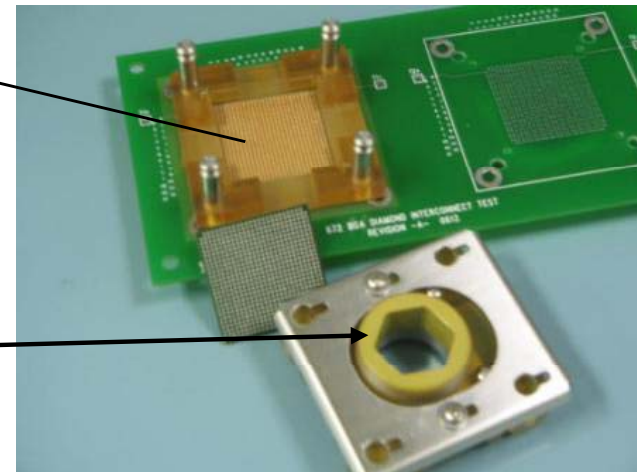
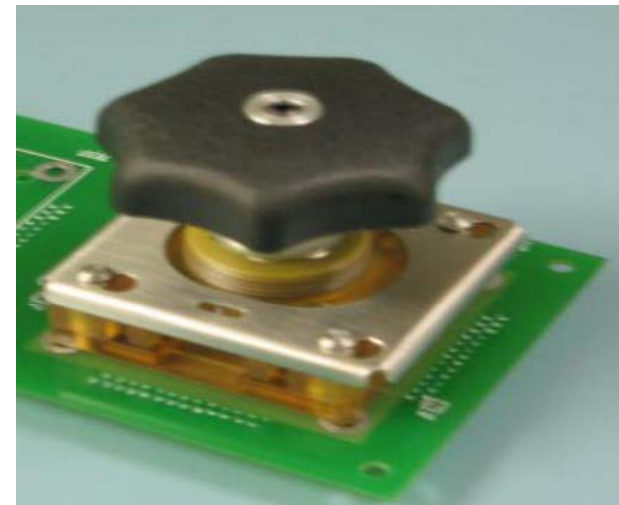
# Manual Device Testing

## Example: 6-10G/bit

### Arm Processor Socket



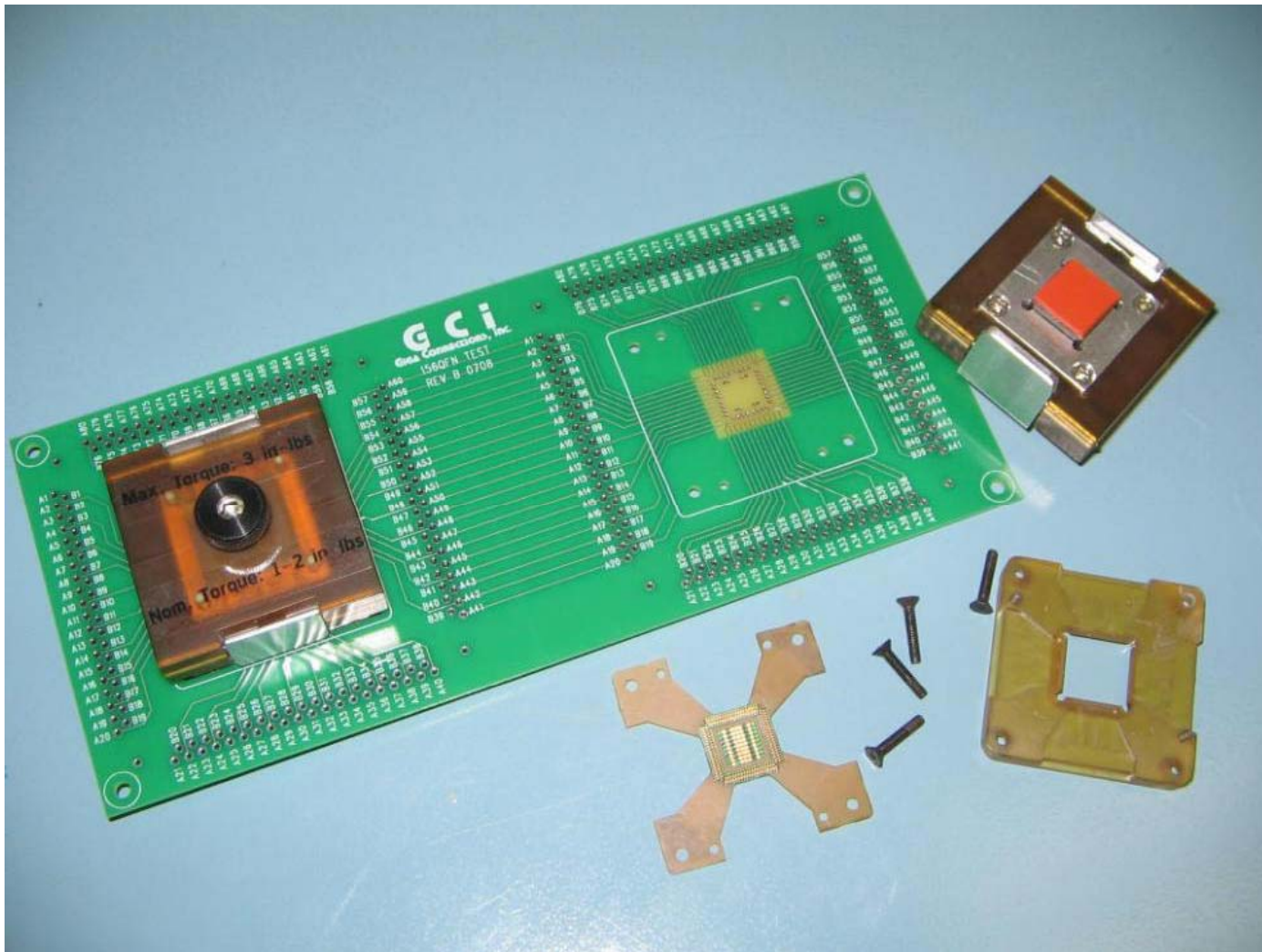
Interposer showing Cantilevers under Kapton interposer



Quick Release Screw Top

# QFN Manual

## Test Sockets 0.5 mm pitch



# 10G/bit BGA 676 Socket

## 4 PAM IP DUT/100ps rise time

Full socket Assy.

35w Heat Sink Assy.

10G/bit Eye Diagram going through Socket and test board

Back Side Stiffener

Two layer Conductive diamond Pin-Less Interposer™

Mfg. Socket Test Board

10Gbit 4PAM EYE

108D14

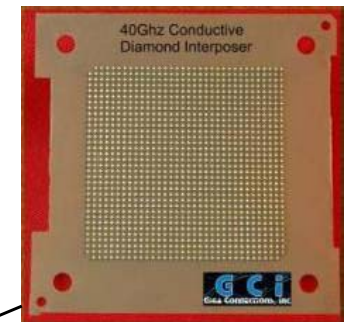
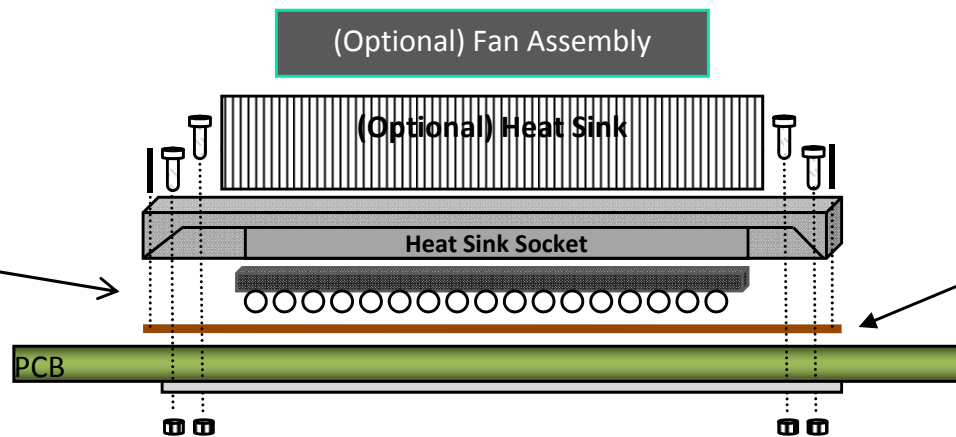
**Enigma**  
semiconductor

# Low Cost OEM Manufacturing Socket

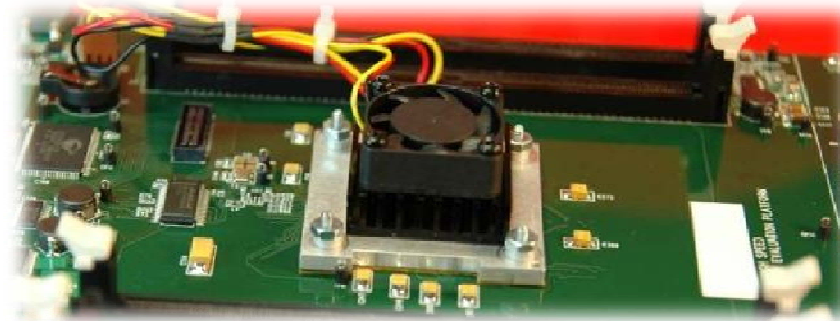
Same Performance, Simpler Design, Volume OEM Socket



Device Package  
(Xilinx Vertex5 1150 BGA)



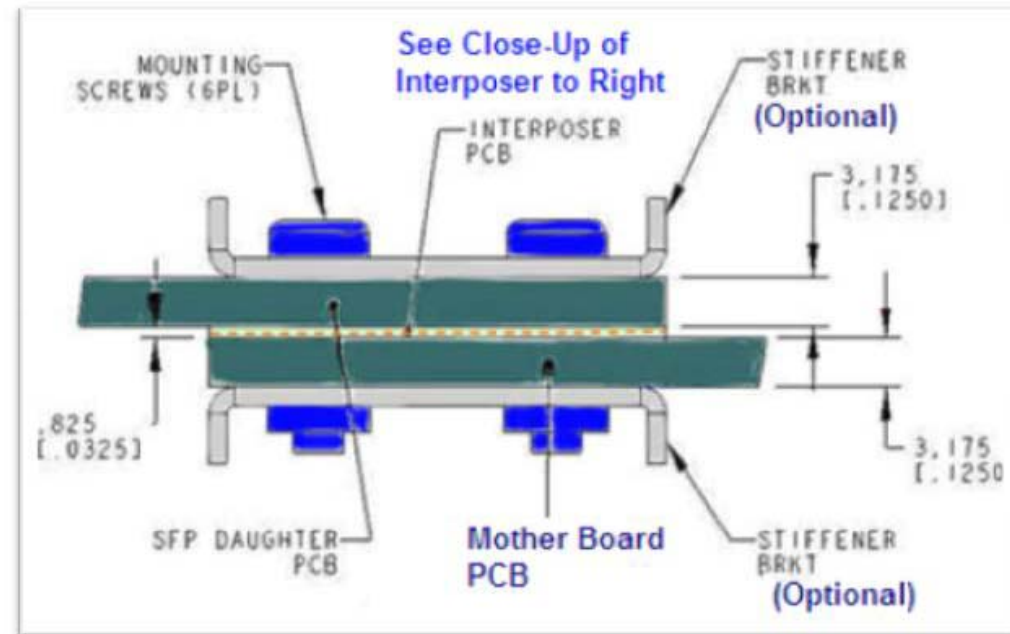
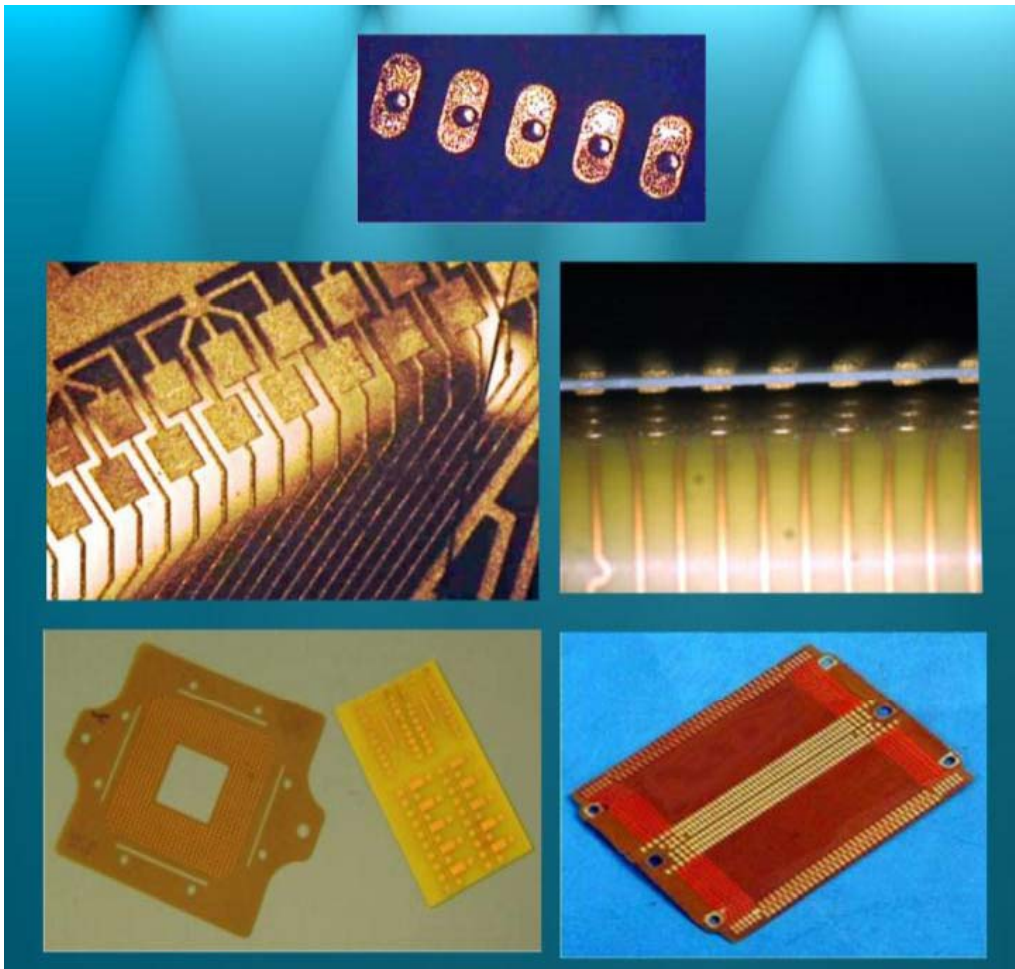
40 GHz/14ps  
GCI Pin-Less Interposer™



Final Heat Sink Socket Assembly With Fan Mounted  
On OEM Printed Circuit Board

# Board on Board

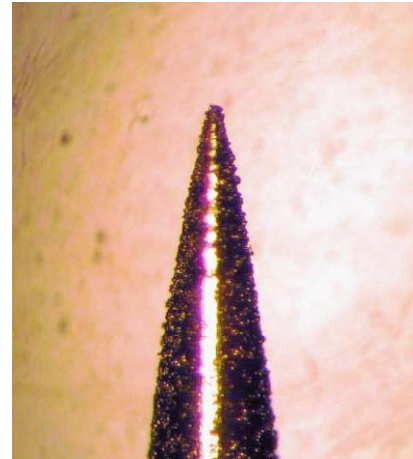
## 40Ghz/14psPin-less Interposer™



# Conductive Diamond Probes



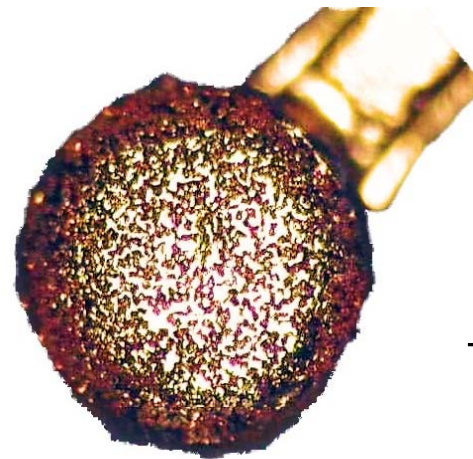
50Um  
Wafer Probe



10Um  
Wafer Probe



10mils  
Instrument Probe



10 mils  
Test Pad



# For More Information

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- Company:
  - Giga Connection, Inc.
  - [www.gigaconnections.com](http://www.gigaconnections.com)
  - Sales:
    - Brian Shumaker
    - brian@comcast.net
    - Ph 650 593-7083