Bridging the Gap

Dong Weon "Dan" Hwang – HiCon Co., Ltd.
Noel Del Rio – NXP Semiconductors
Paul Schubring – HiCon Global / HighRel, Inc.

TestConX™
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HiCon®
NXP
HighRel, Inc.

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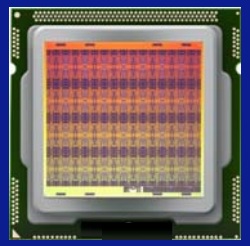
- Driving Influences & Tooling Challenges
- The Test Gap
- “HyBrid” Solution
- S-Parameter Measurement Results
- Test Data
- Conclusions & Next Steps

Driving Influences

Technology treadmill never slows

- Higher data rates
- Finer pitch
- Higher pin counts
- Higher power

5G Networks



Quantum Computing

AI / Neural Networks

Autonomous Driving

5G Accelerator Card

Photo Sources: Intel, Samsung, Waymo

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Key Tooling Challenges

- Higher Pin Counts
  - 2,000+ pin count are main-stream
  - 4,000+ pin count more prevalent
- Higher Data Rates
  - 28 Gbps
  - Automotive radar
- Finer Pitch
  - Solutions for < 0.3mm for test hardware not readily available

Package Pitches Down to 0.2mm

Contact Solutions for Fine Pitch Applications

0.25mm 0.20mm

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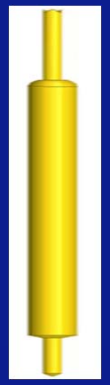
The Test Gap for Fine Pitch / High Speed



Spring Probes:

- Typically long life
- Good electrical performance
- Wide temperature range
- Support Very Fine pitch
- Typically used for high cycle count test applications
- Machined pin cost is high and rapidly increases for fine pitch & high speed support

Elastomer Contacts:

- Excellent electrical performance
- Lower life cycle expectancy
- Reduced temperature range
- Fine pitch support
- Typically used for validation / characterization applications

Elastomer Contact

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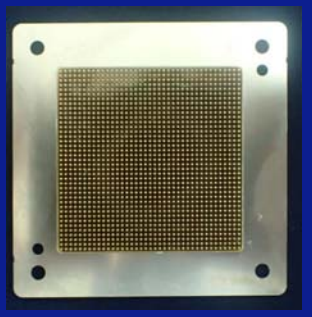
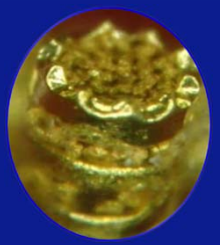
"HyBrid" Solution

- Developed to address fine pitch challenges
  - Initially developed to break through < 0.3mm pitch barrier with a cost-effective solution
  - Available at 0.2 mm minimum pitch
- Contact system combines a mechanical pin with traditional elastomer
  - Contact system benefits from excellent electrical performance
  - Mechanical performance that meets long life and tri-temp temperature range requirements



1mm 1521-pin HyBrid Socket



HyBrid Contact Pin

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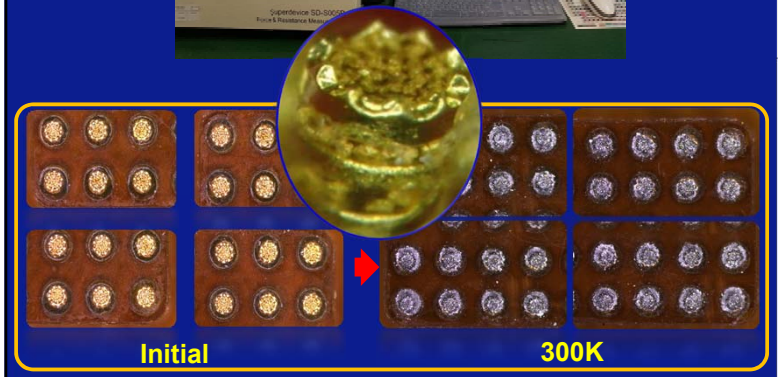
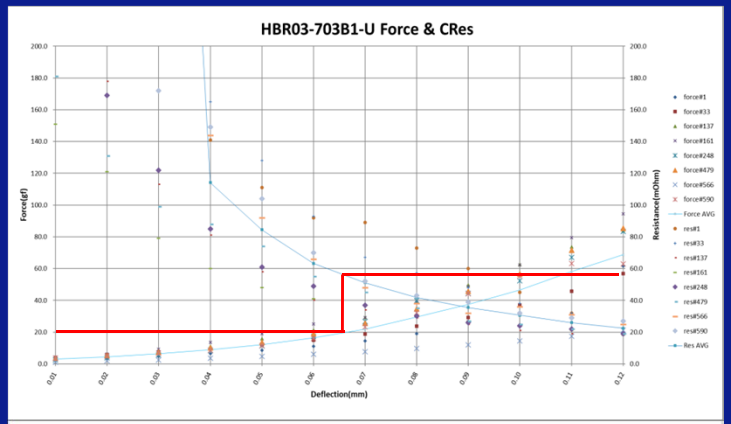
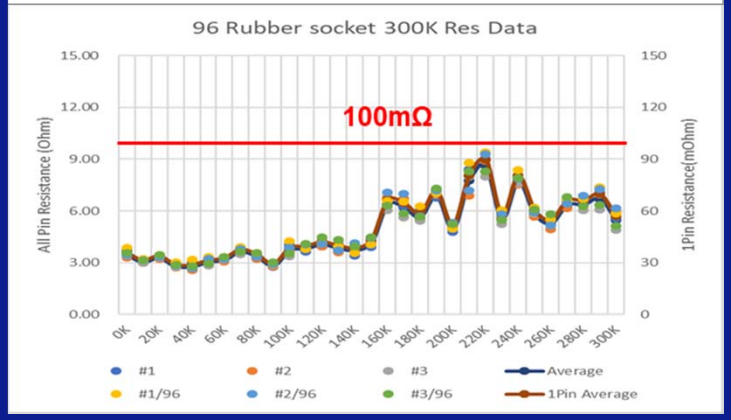
HyBrid Lab Data - FDR







Pin Count: 700
Pitch: 0.3mm

Cycle Count	96BGA	
	Ave [Ω]	1Pin [mΩ]
Initial	3.47	36
100K	3.71	39
200K	4.96	52
300K	5.47	57

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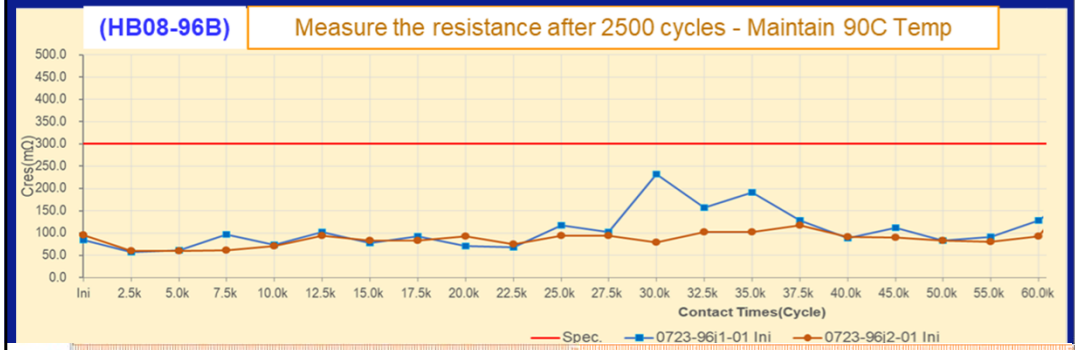
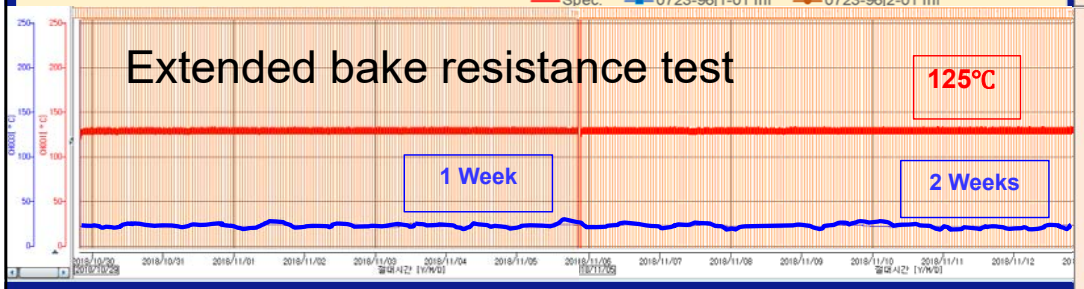
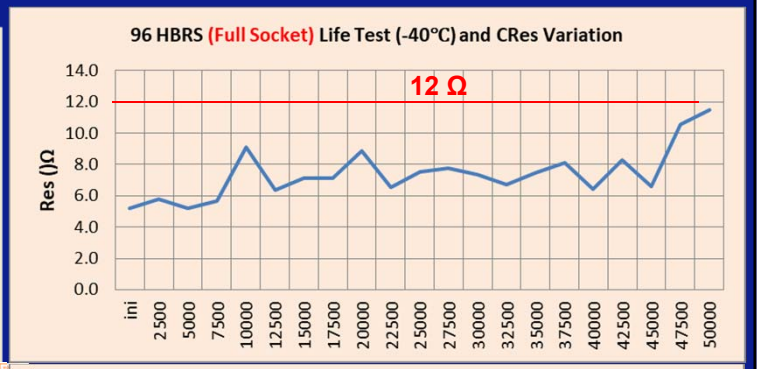
HyBrid Temp Test Data

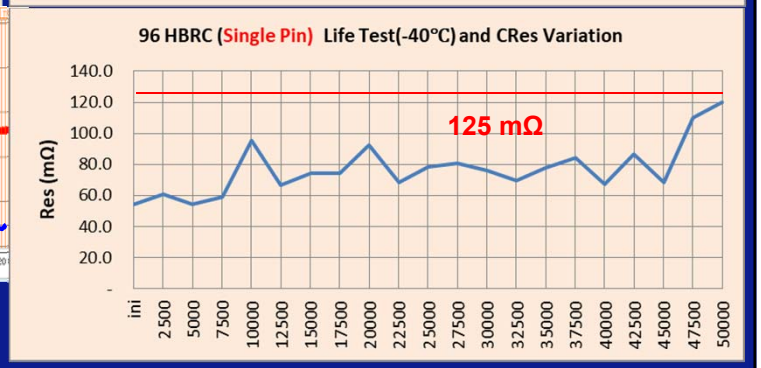
90°C Cycle Test Data





-40°C Cycle Test Data





0.8mm pitch

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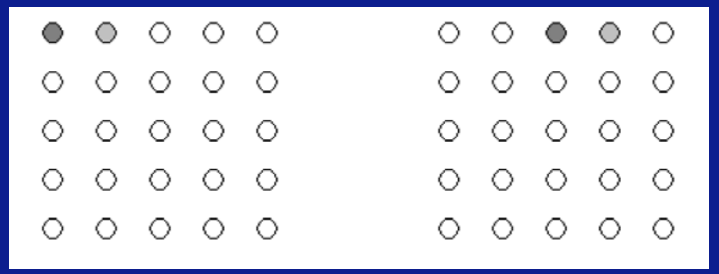
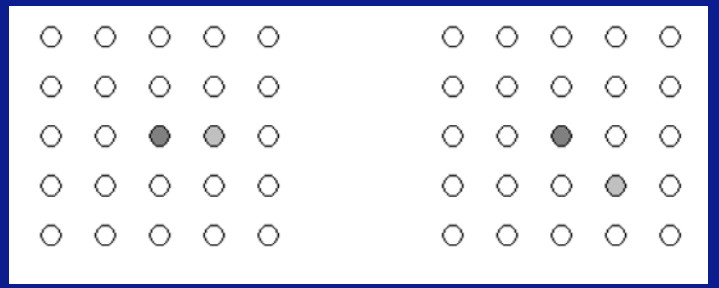
S-Parameter Measurement Setup

- Test sample:
  - 0.4mm pitch HyBrid
- Measurement Conditions:
  - G-S-G / G-S-S-G
  - Corner / Edge / Field / Diagonal
  - Up to 100GHz



Corner Edge



Field Diagonal

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S-Parameter Measurement Results

- Test sample:
  - 0.4mm pitch HyBrid
- Measurement Conditions:
  - G-S-G / G-S-S-G
  - Corner / Edge / Field / Diagonal
  - Up to 100GHz

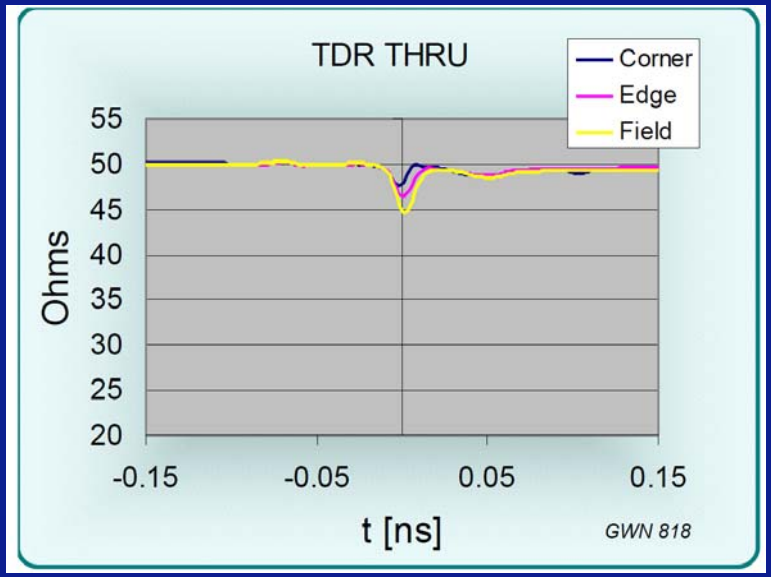
	Corner	Edge	Field	
Delay	2.6	2.6	2.7	ps
Risetime open	30	28.5	28.5	ps
Risetime short	28.5	28.5	27	ps
Risetime thru, 50Ω	12	12	12	ps
Insertion loss (1dB)	62.6	65.3	63.7	GHz
Insertion loss (3dB)	82.5	>100	>100	GHz
VSWR (2:1)	>100	>100	>100	GHz

Site	L1
Corner	0.20
Edge	0.18
Field	0.16
Diagonal	0.16

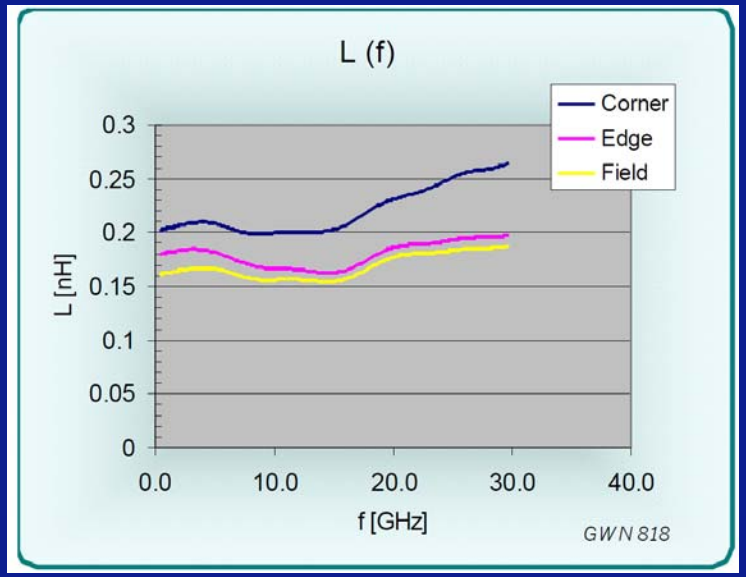
Site	Zo
Corner	47.6
Edge	46.4
Field	44.6

Data by GateWave Northern

S-Parameter Measurement Results



Site	Zo
Corner	47.6
Edge	46.4
Field	44.6



Site	L1
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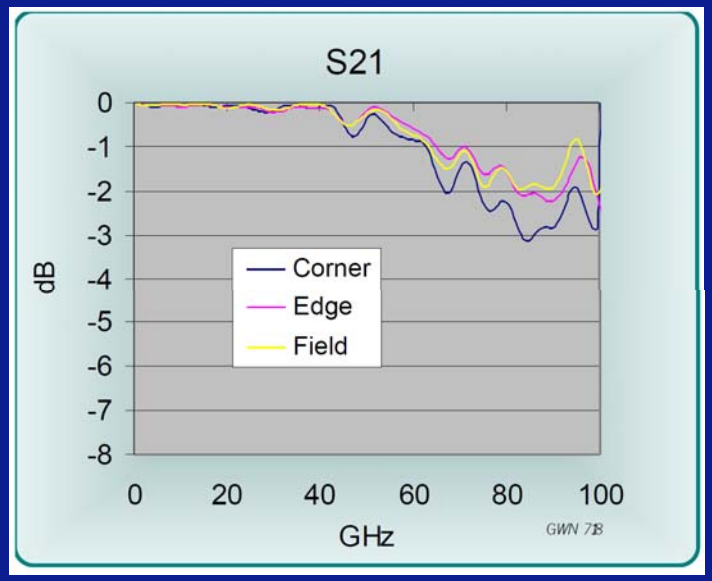
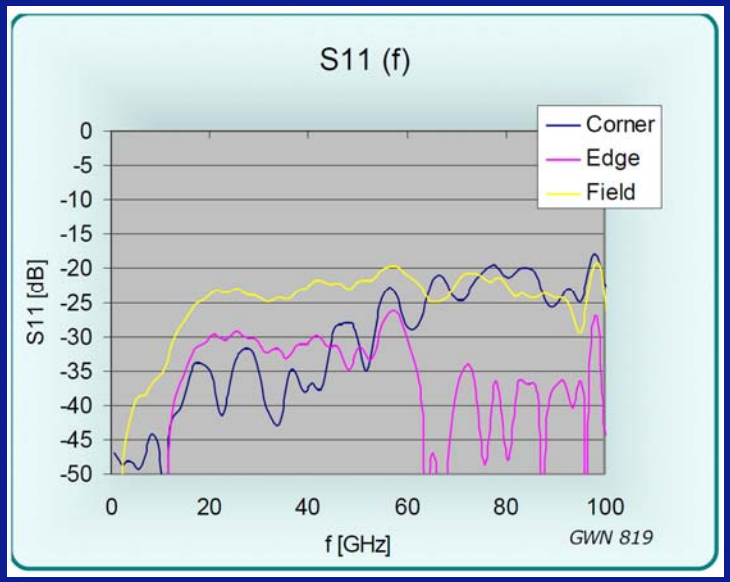
S-Parameter Measurement Results





	Corner	Edge	Field	
Insertion loss (1dB)	62.6	65.3	63.7	GHz
Insertion loss (3dB)	82.5	>100	>100	GHz

	Corner	Edge	Field	
Return Loss (-20dB)	76.2	> 100	56.1	GHz

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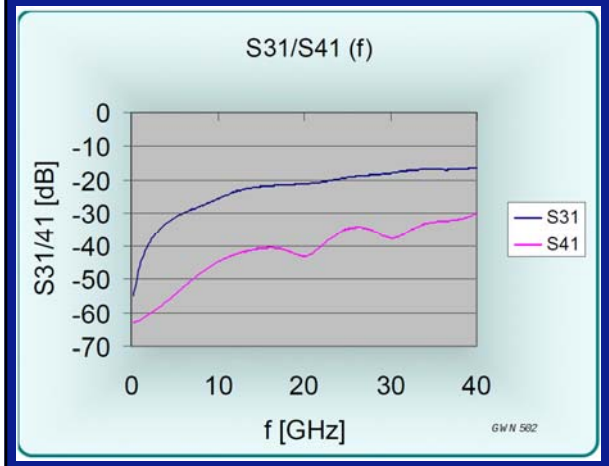
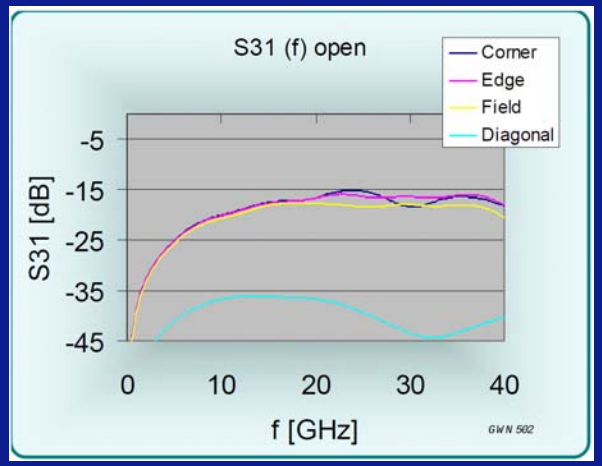
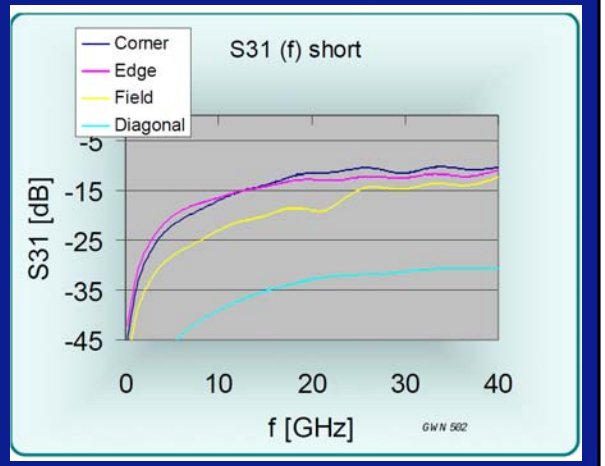
S-Parameter Measurement Results



FEXT (S41) & NEXT (S31)



Open Circuit Cross Talk



Short Circuit Cross Talk

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NXP Validation: LX2 HSSI Board Measurement Data

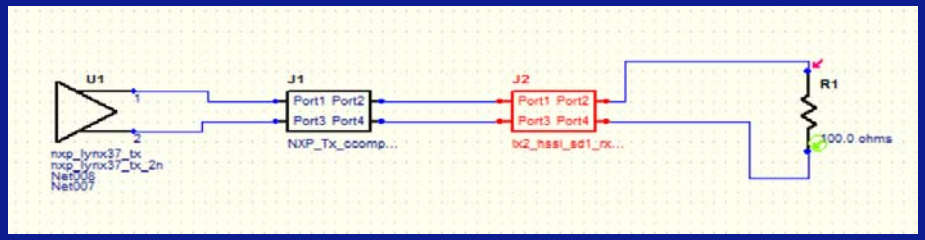
Measurement Setup:

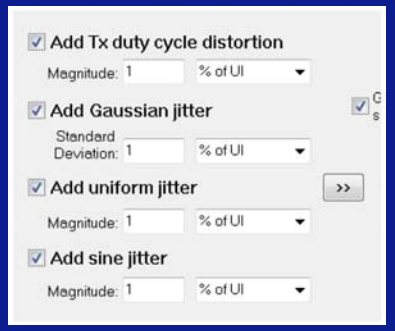
- VNA DC to 30GHz @ 3mhz resolution
- HiCon LX2 Test Socket
- Differential Measurements
- Five SERDES lanes measured
- Room temp using 70GHz VNA
- HyperLynx Simulator on one lane:
- KR28.5, 25.78125G data rate

Summary of Results:

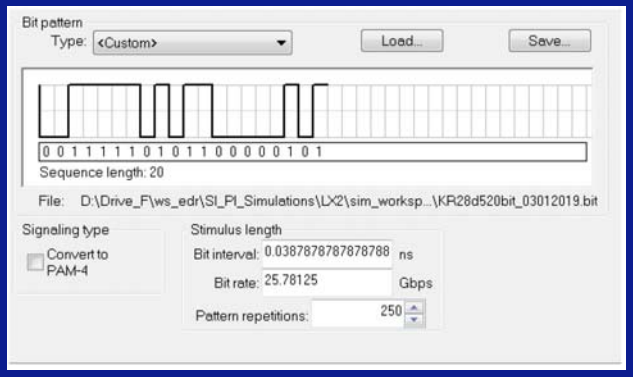
- HiCon socket approved for 28G data rate for LX2 SERDES
- Differential Impedance for lane measured 100 ± 2 Ω for all 5 lanes
- S-parameter all acceptable
  - Insertion loss dominated by PCB trace lengths
  - Return loss better than -10db up to 25GHz

LX2 Simulator





IBIS Model – DUT / Package
Signal Path – Socket and HSSI Board
VNA – Measured Touchstone Files



LX2 HSSI TDR Plot, SD3 Trace

M2 Top of Socket
101.673 Ohms

M3Bottom of Socket
99.950 Ohms

Board Via

PCB Trace SD3, R0

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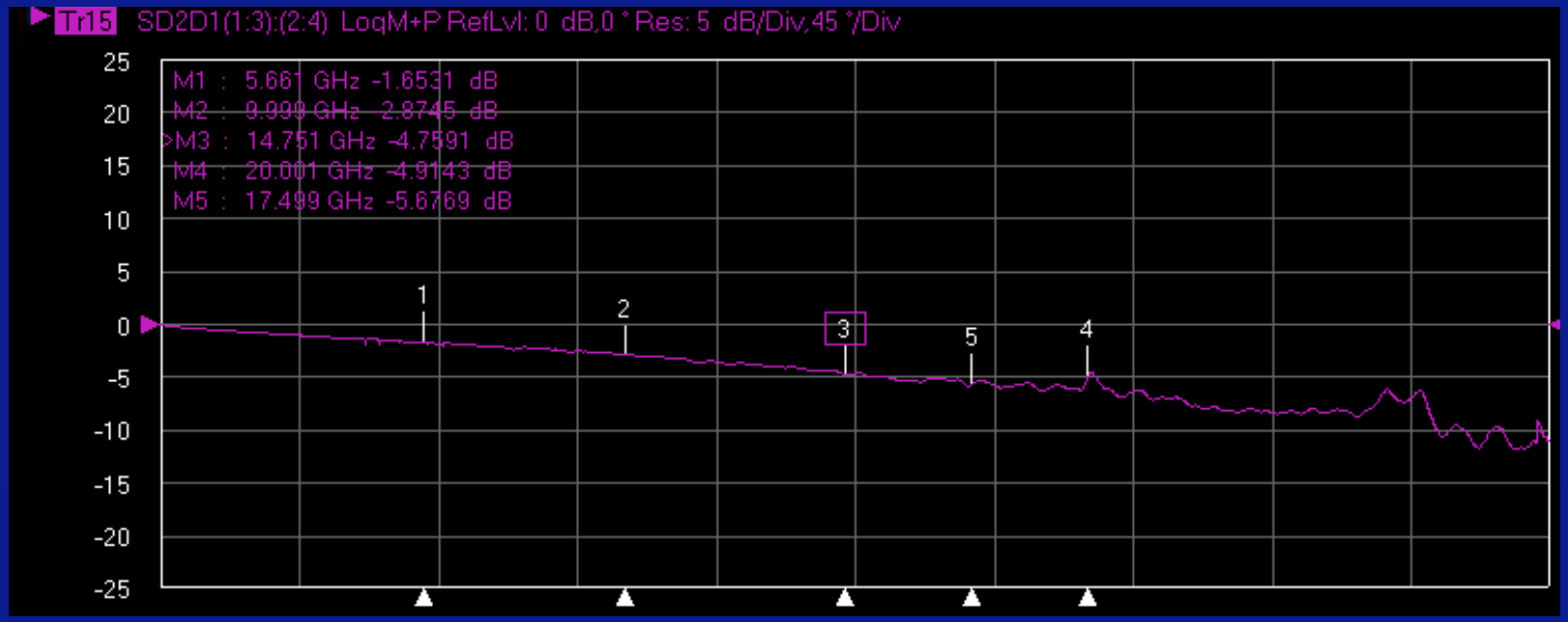
LX2 HSSI S21 Differential Insertion Loss



Linear response up to between 17+Ghz and <20Ghz

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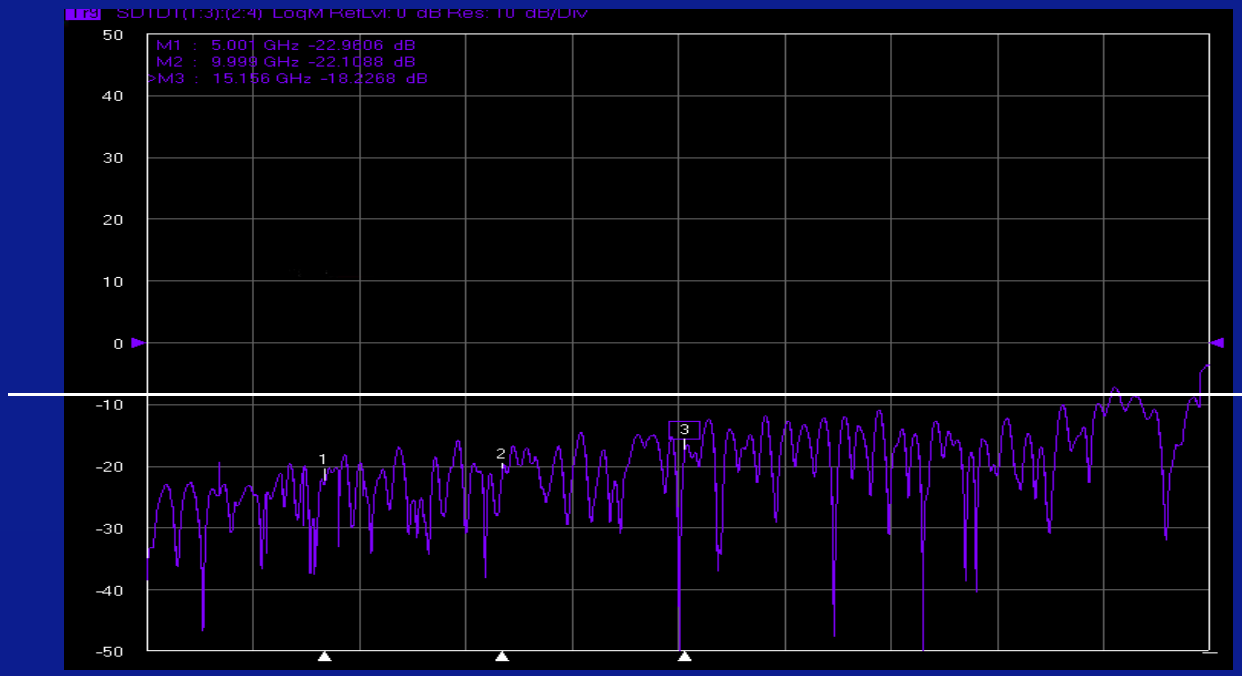
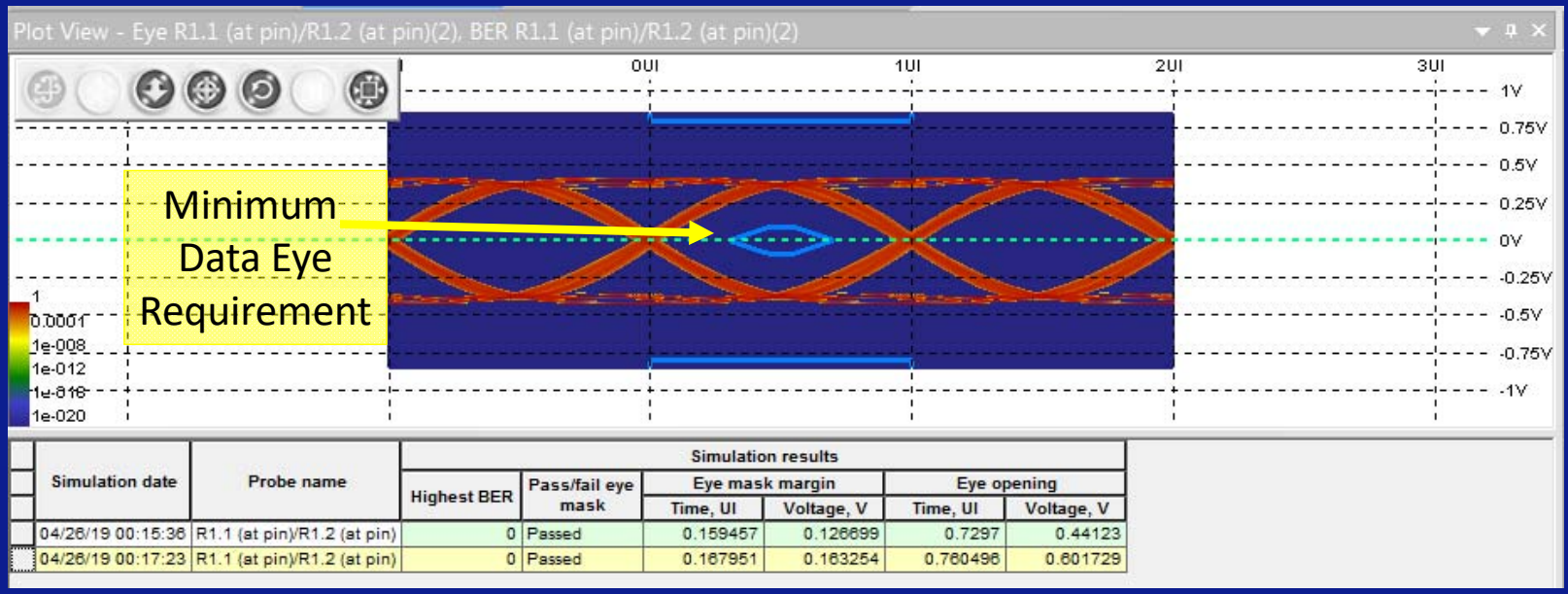
LX2 HSSI S11 Differential Return Loss



-10dB

Return loss better than -10dB up to ~ 25 GHz

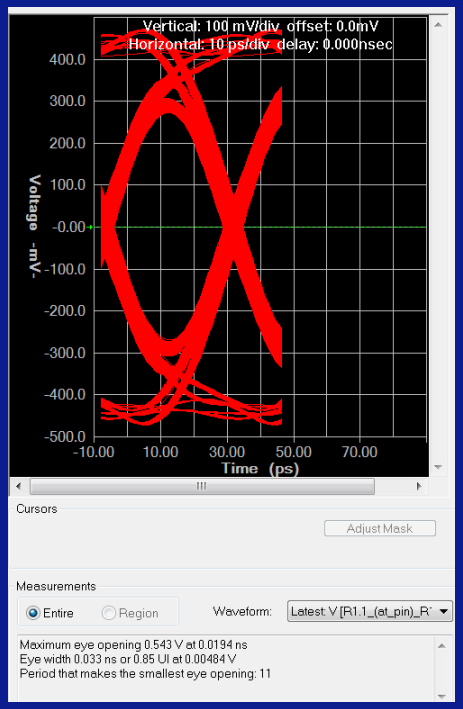
LX2 HSSI Data Eye – Without Equalization



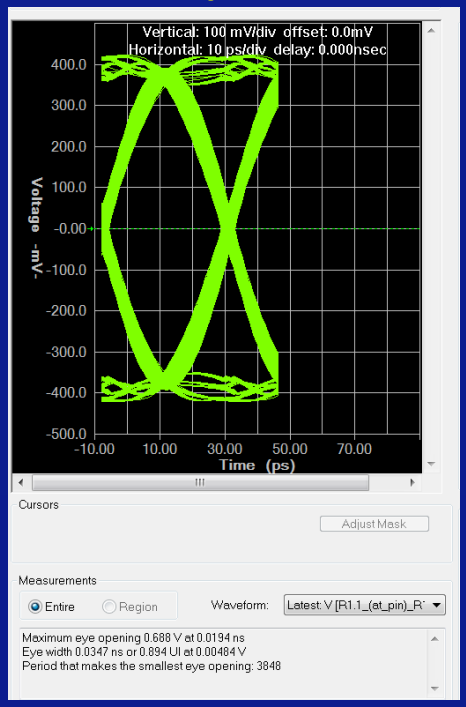
Simulation date	Probe name	Simulation results					
		Highest BER	Pass/fail eye mask	Eye mask margin		Eye opening	
				Time, UI	Voltage, V	Time, UI	Voltage, V
04/26/19 00:15:36	R1.1 (at pin)/R1.2 (at pin)	0	Passed	0.159457	0.126699	0.7297	0.44123
04/26/19 00:17:23	R1.1 (at pin)/R1.2 (at pin)	0	Passed	0.167951	0.163254	0.760496	0.601729

LX2 HSSI, Data Eye Without and With Equalization

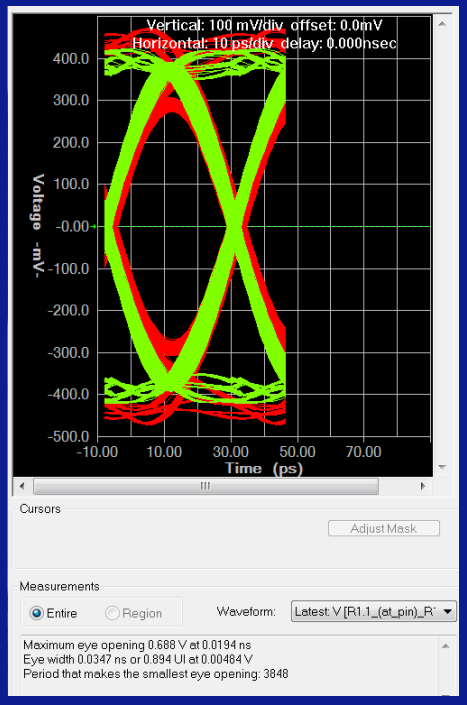
No Equalization



With Equalization



Super Imposed



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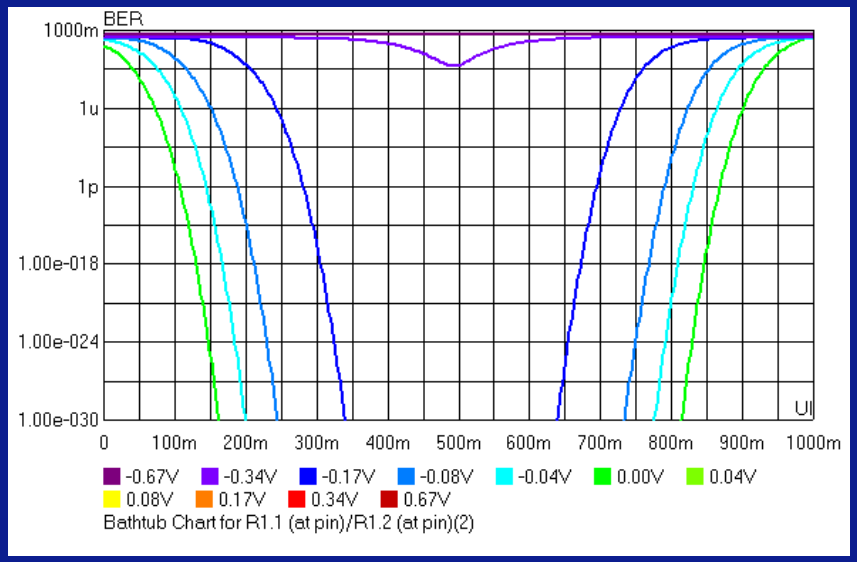
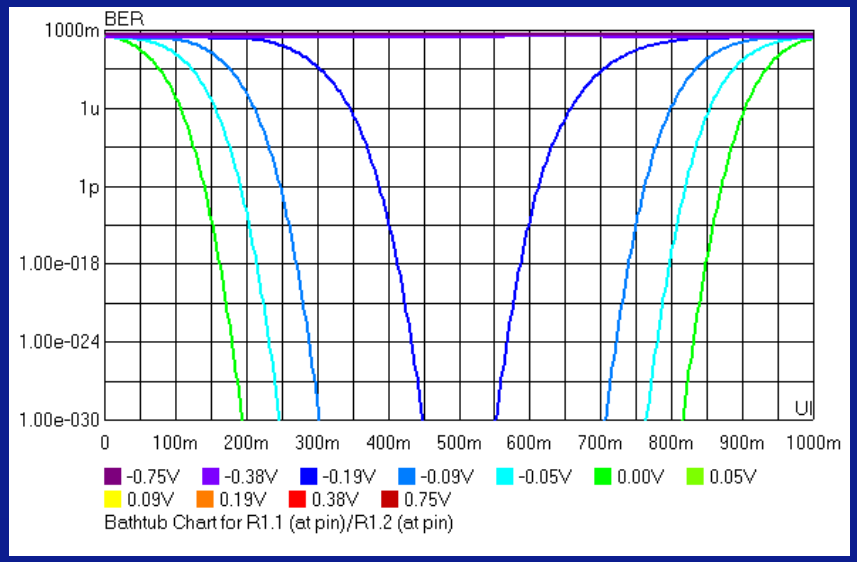
LX2 HSSI

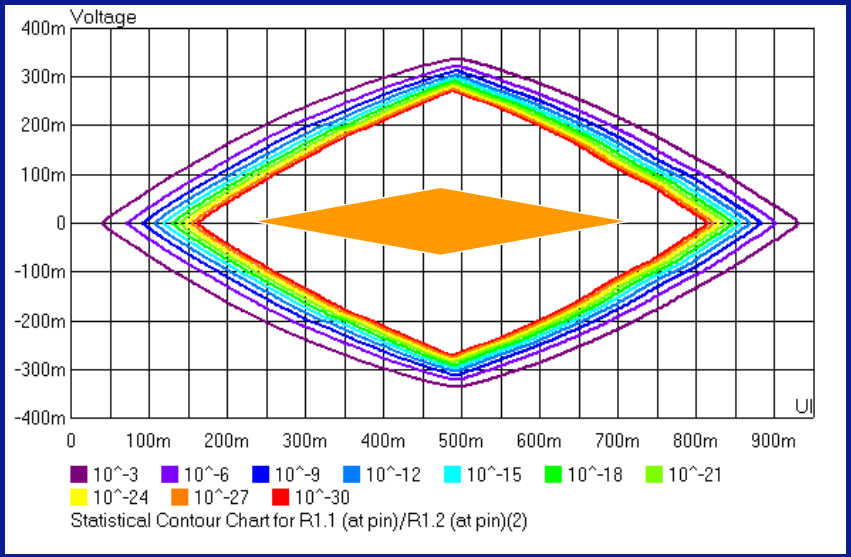


With Pre-emphasis and De-emphasis

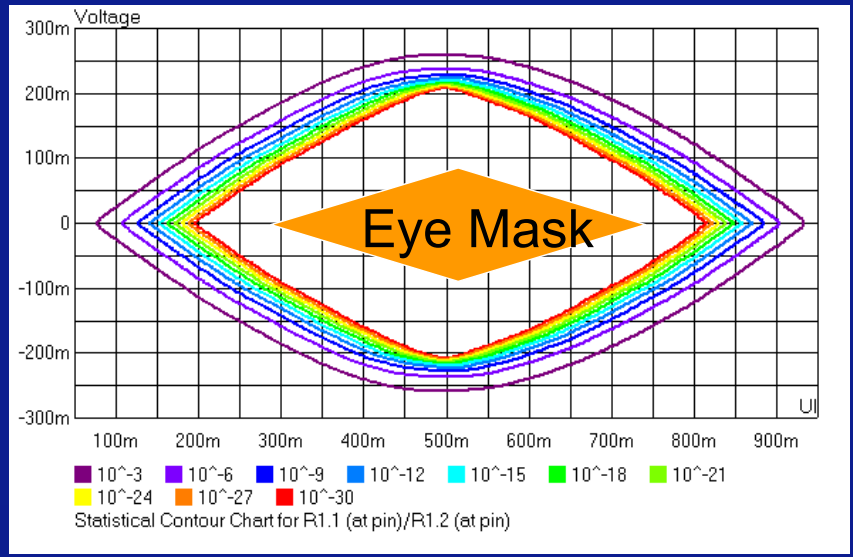


Without Pre-emphasis and De-emphasis

LX2 HSSI



With Pre-emphasis and De-emphasis



Without Pre-emphasis and De-emphasis

Conclusions & Next Steps

- Product family combining mechanical pin with elastomer contact ("HyBrid") was developed to meet fine pitch challenges down to 0.2 mm pitch
- Demonstrated excellent mechanical and electrical performance in the lab and end use application
  - Qualified for 28Gbps Applications
- New product development, testing and data collection for BI, Test, and Validation applications underway for this innovative technology

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