

IT3-38mm SI Report

Three-Piece Mezzanine Connector for 20+ Gbps Applications

December 16, 2009



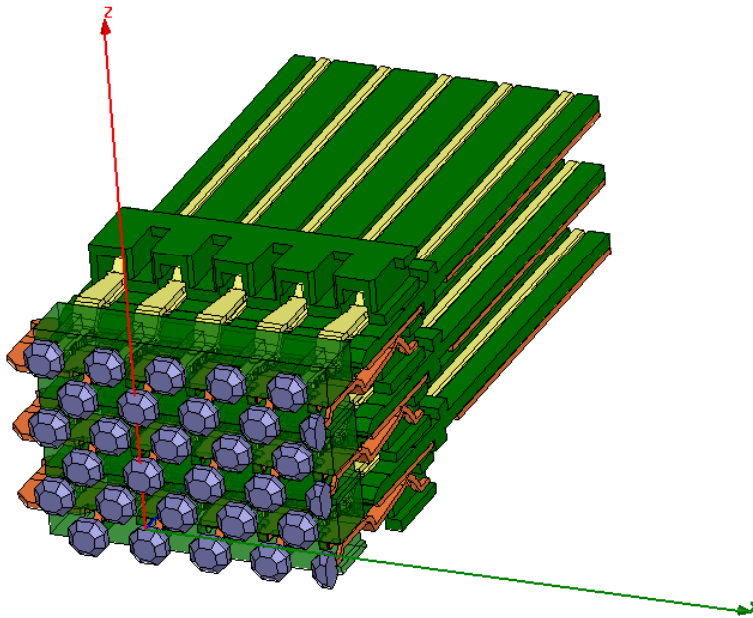
HIROSE ELECTRIC

Outline

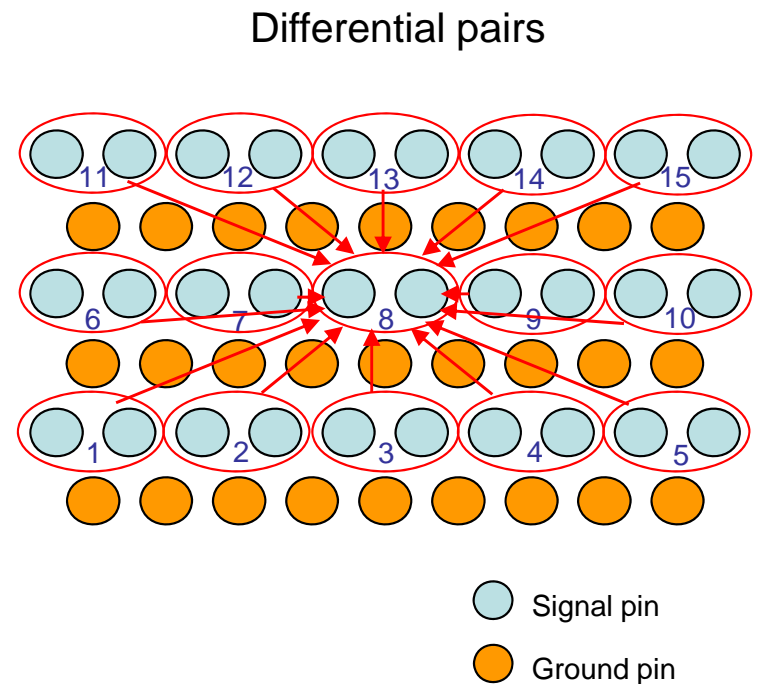
- HFSS simulation models for connector and via
- Insertion and return losses, NEXT, FEXT, and impedance profile
- Insertion loss to crosstalk ratio (ICR)
 - Fully populated vs. 50% density
 - Connector-only vs. full channel
- Eye diagrams
- Summary
- Appendix
 - Measurement vs. simulation correlation
 - Measured ICR for IT3-38mm

HFSS simulation model

- A .s60p file was created, and the differential pair's response was examined.



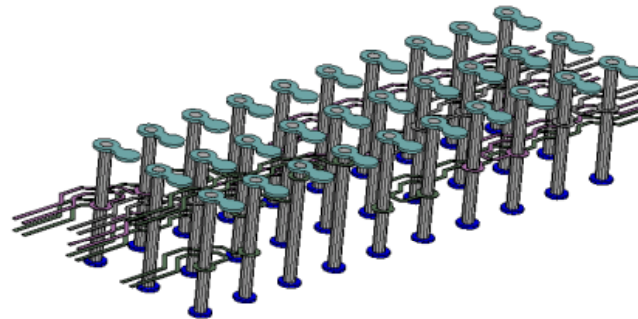
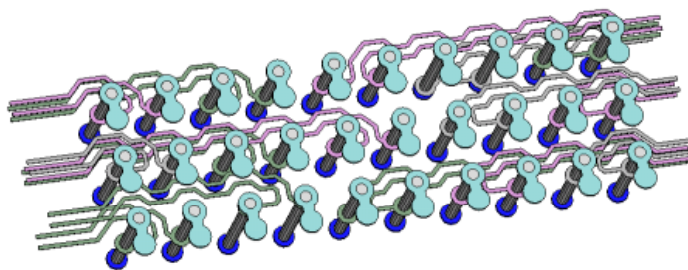
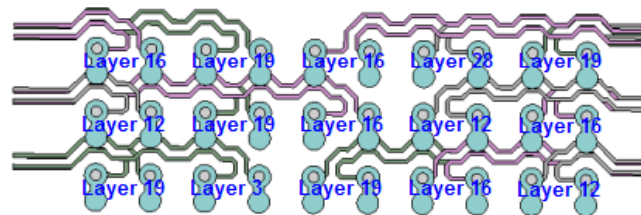
Simulation model for IT3-38mm
(only a quadrant of the model is shown)



Signal pin
Ground pin

Via model

- A .s60p Touchstone file was also created to study the effect of via stub and coupling.



Layer No.			Mil
		Solder mask	0.5
1	TOP		2.84
		Pre-preg	4.5
2	Ground		0.7
		Core	3
3	Sig 1		0.7
		Pre-preg	3.5
4	Sig 2		0.7
		Core	3
5	Ground		0.7
		Pre-preg	3.5
6	Ground		0.7
		Core	3
7	Sig 3		0.7
		Pre-preg	3.5
8	Sig 4		0.7
		Core	3
9	Ground		0.7
		Pre-preg	3.5
10	Ground		0.7
		Core	3
11	Sig 5		0.7
		Pre-preg	3.5
12	Sig 6		0.7
		Core	3
13	Ground		0.7
		Pre-preg	3.5
14	Ground		0.7
		Core	3
15	Sig 7		0.7
		Pre-preg	3.5
16	Sig 8		0.7
		Core	3
17	Ground		0.7
		Pre-preg	3.5
18	Ground		0.7
		Core	3
19	Sig 9		0.7
		Pre-preg	3.5
20	Sig10		0.7
		Core	3
21	Ground		0.7
		Pre-preg	3.5
22	Ground		0.7
		Core	3
23	Sig11		0.7
		Pre-preg	3.5
24	Sig12		0.7
		Core	3
25	Ground		0.7
		Pre-preg	3.5
26	Ground		0.7
		Core	3
27	Sig13		0.7
		Pre-preg	3.5
28	Sig14		0.7
		Core	3
29	Ground		0.7
		Pre-preg	4.5
30	BOTTOM		2.84
		Solder mask	0.5
		Total thickness (mil)	121.78

IEEE 802.3ap channel spec.

- IEEE 802.3ap defines the channel spec. of insertion-loss-to-crosstalk ratio (ICR) up to 5 GHz for 10 Gbps data rate. We will extrapolate this ICR curve to 10 GHz for 20 Gbps data rate.

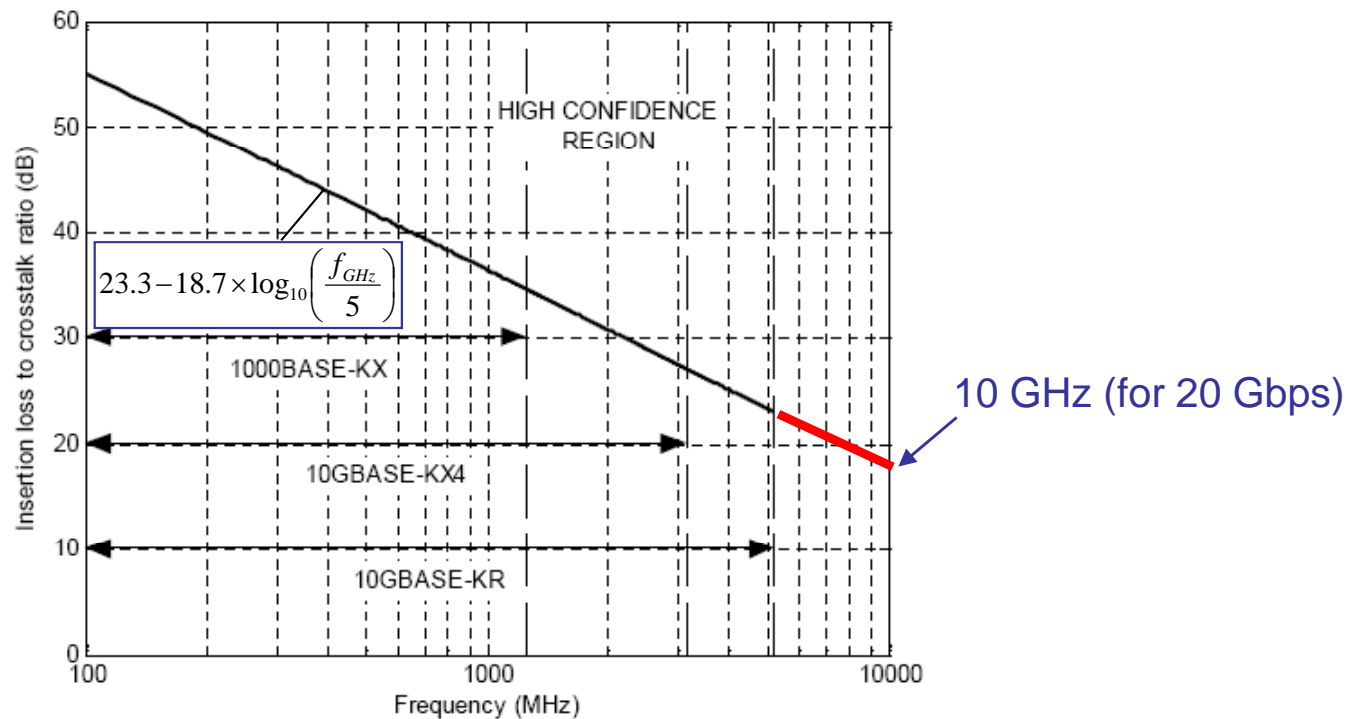
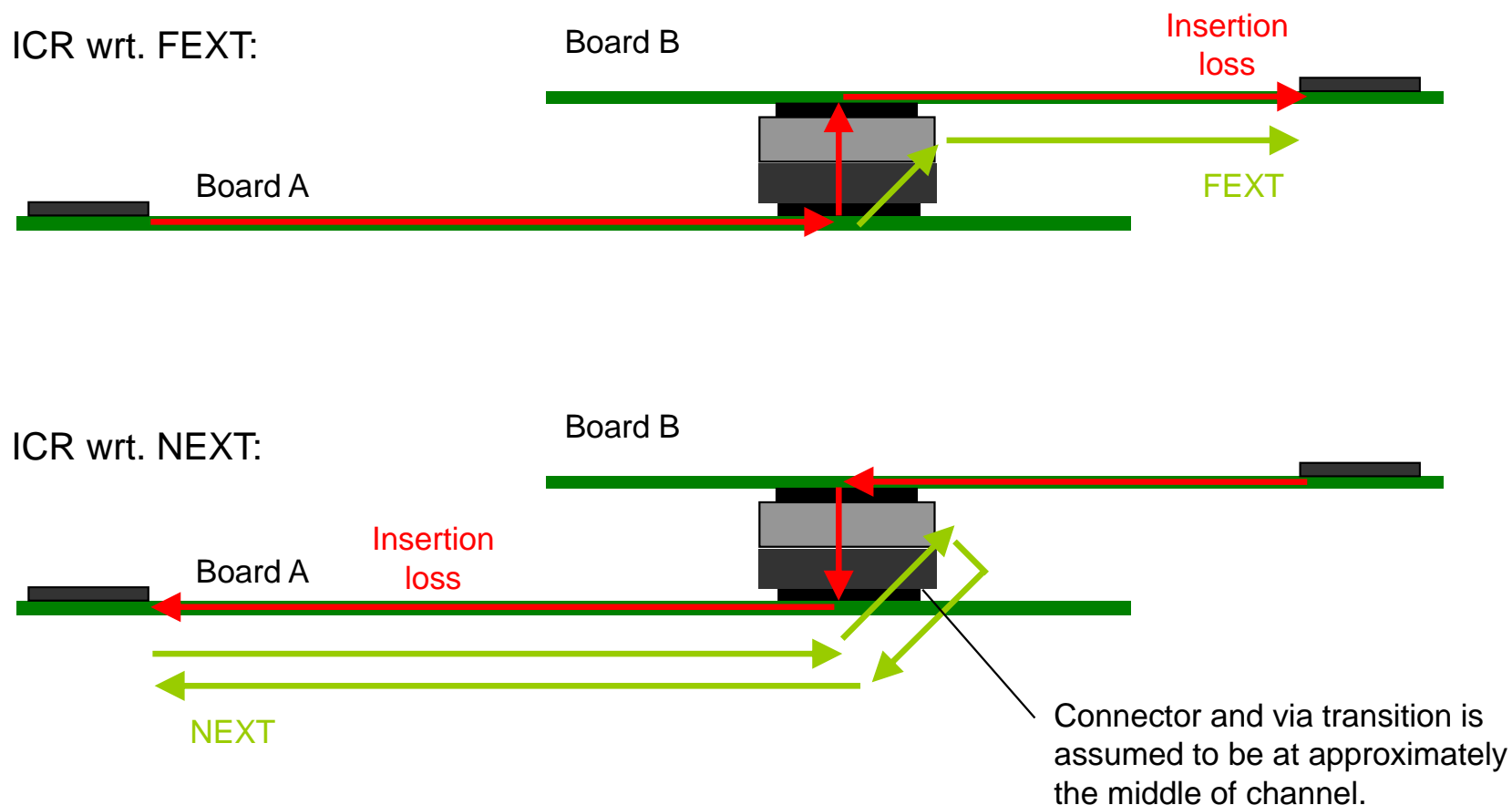


Figure 69B-8—Insertion loss to crosstalk ratio limit

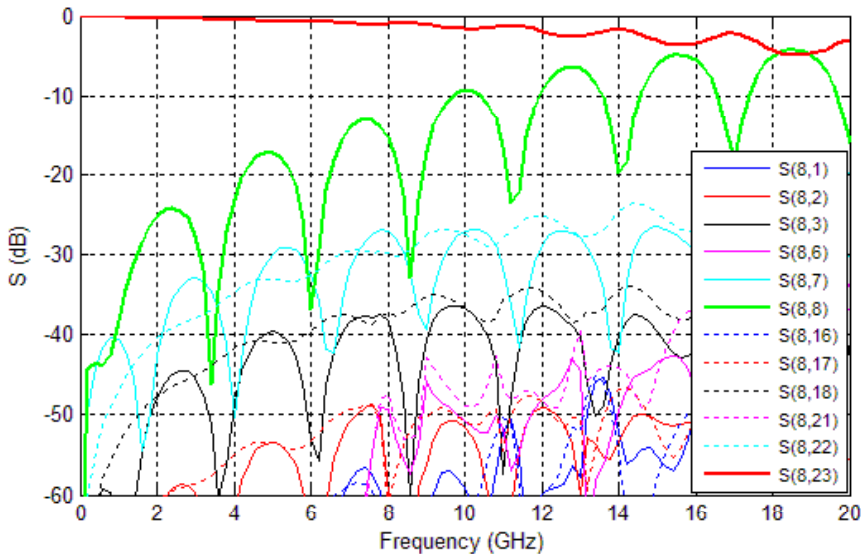
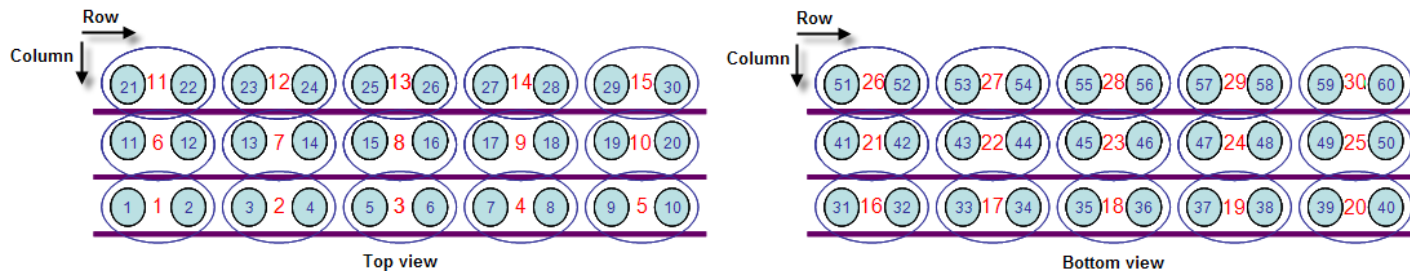
Connector's ICR

- The connector and via transition's contribution to ICR is independent of channel length, because the insertion loss and crosstalk attenuate at the same rate.



IT3-38mm connector-only response (Fully populated)

- All insertion and return losses, and NEXT and FEXT are shown for the center pair.



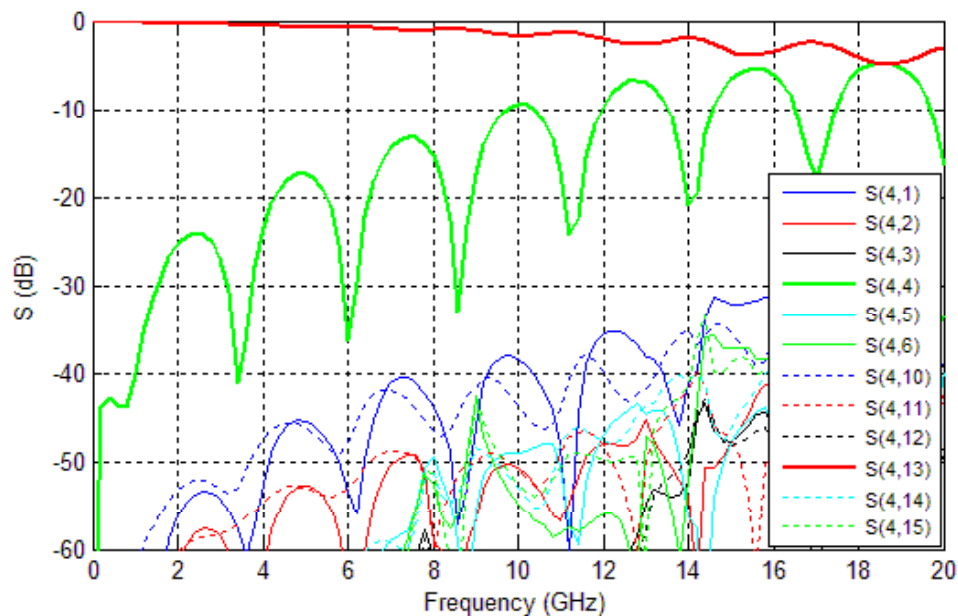
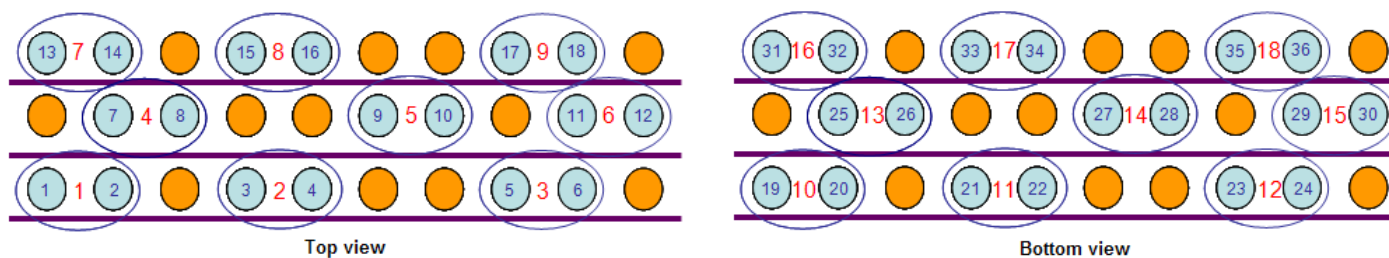
IT3-38mm Differential Impedance (Ohm)			IT3-38mm Differential Delay (ps)		
Column			Column		
N	2 to N-1	1	N	2 to N-1	1
100.05	100.14	101.09	218.51	218.30	219.21
99.00	99.14	100.49	217.54	217.41	217.73
99.09	98.91	100.22	217.31	217.53	217.80
99.00	99.14	100.49	217.54	217.41	217.73
100.05	100.14	101.09	218.51	218.30	219.21

Row labels: A, C, E, G, J, L, N, R, U, W

Impedance and delay @1 GHz

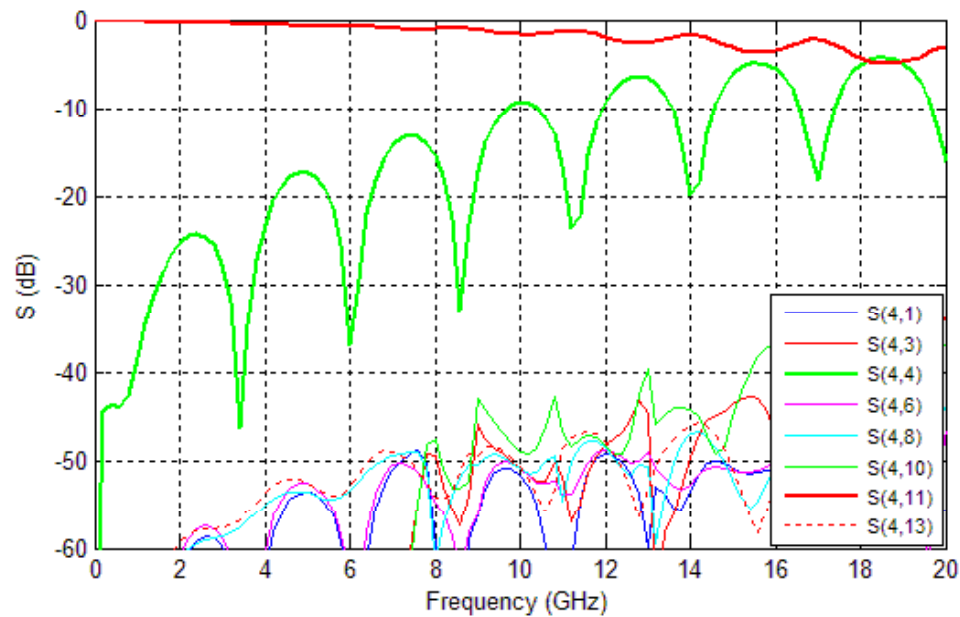
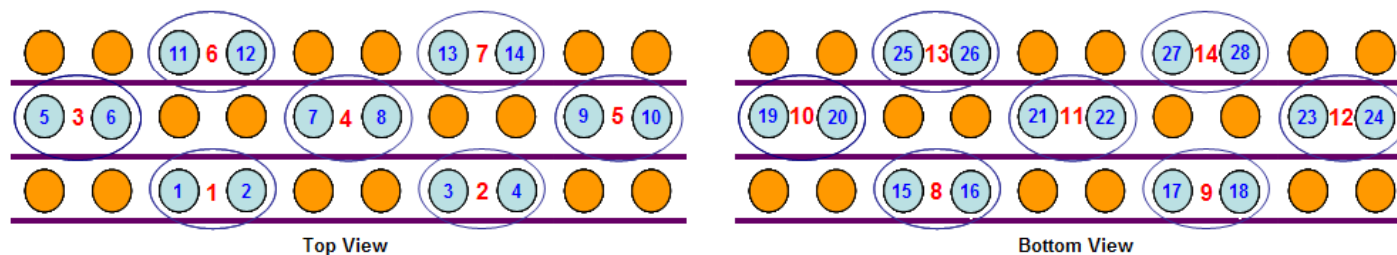
IT3-38mm connector-only response (60% density)

- Both NEXT and FEXT are reduced, if some pins are skipped (i.e., terminated or assigned to low-speed signals).



IT3-38mm connector-only response (50% density)

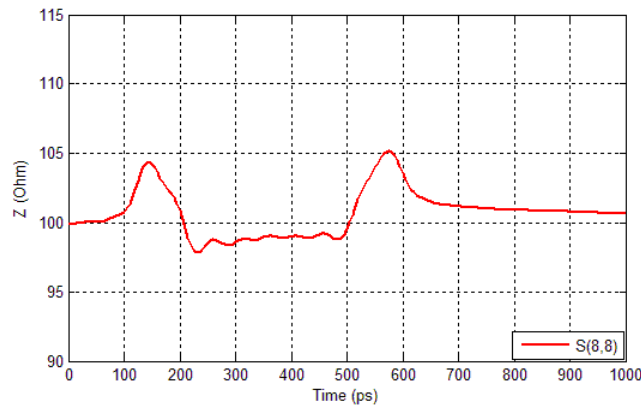
- We observe even less NEXT and FEXT with 50% density.



Impedance at 60ps and 30ps rise time (20%~80%)

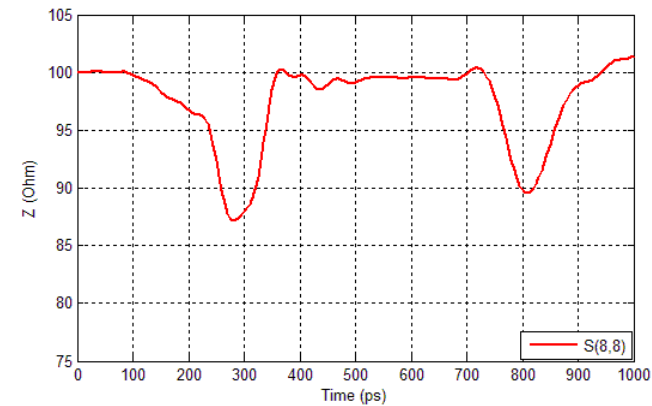
- IT3's receptacles were designed to have slightly high impedance to offset the via's and via stub's low impedance.

Connector only

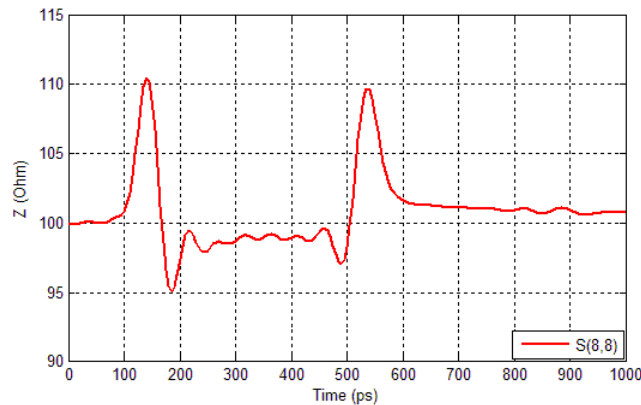


60ps rise time (20%-80%) and 5.25GHz bandwidth

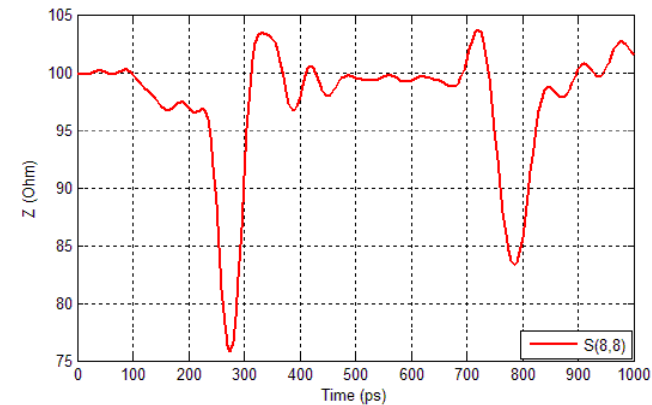
Connector + ~60mil via stubs



60ps rise time (20%-80%) and 5.25GHz bandwidth



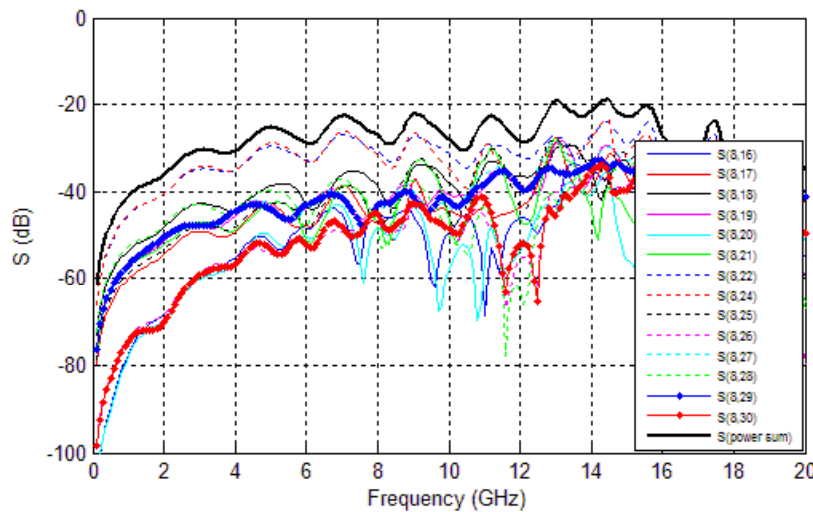
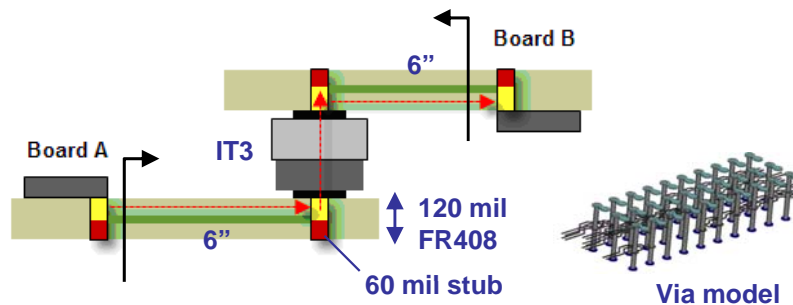
30ps rise time (20%-80%) and 10.5GHz bandwidth



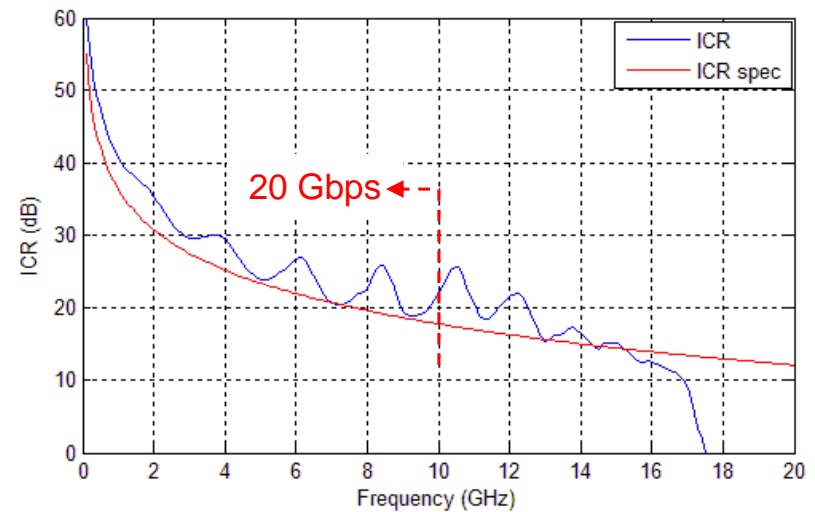
30ps rise time (20%-80%) and 10.5GHz bandwidth

ICR in a full channel (Fully populated)

- ICR with 14-aggressor connector and via FEXT, and ~60 mil stub meets the extrapolated IEEE 802.3ap spec. for 20 Gbps.



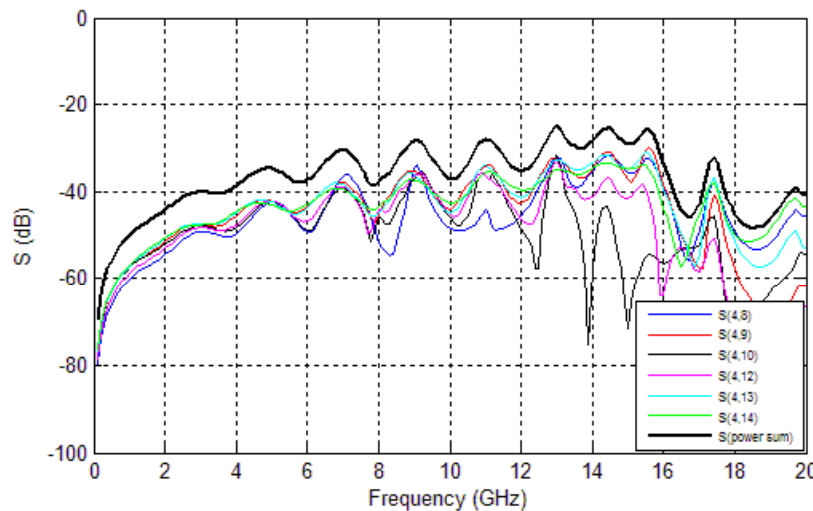
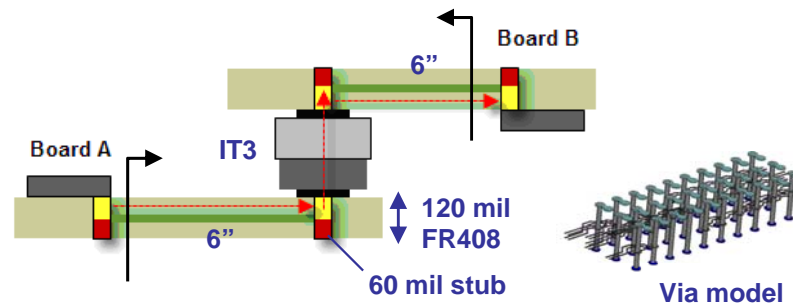
FEXT for via-connector-via
(w/o trace attenuation)



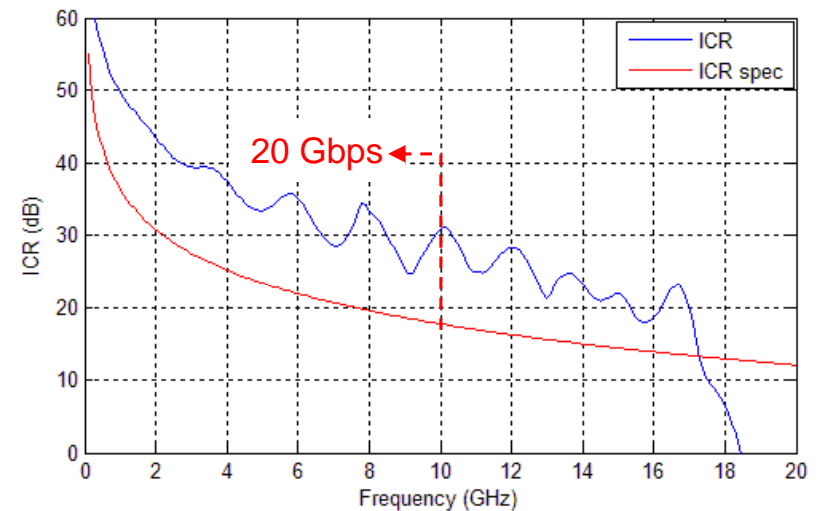
ICR with 14 FEXTs

ICR in a full channel (50% density)

- ICR with 6-aggressor connector and via FEXT, and ~60 mil stub gives plenty of margin @20 Gbps, as compared to the extrapolated IEEE 802.3ap spec.



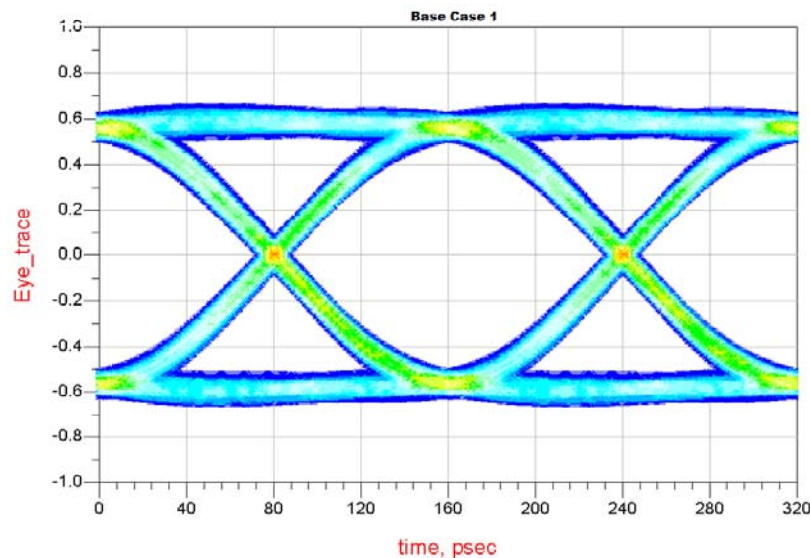
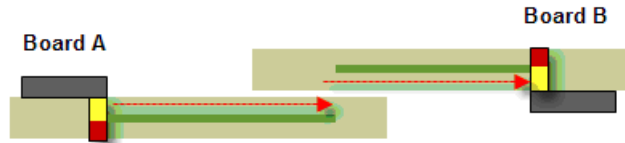
FEXT for via-connector-via
(w/o trace attenuation)



ICR with 6 FEXTs

Channel simulation @6.25 Gbps (Fully populated)

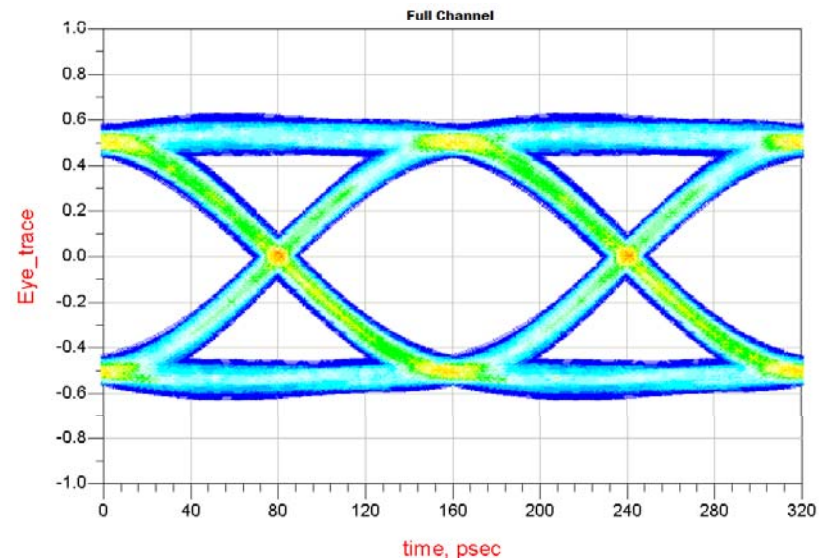
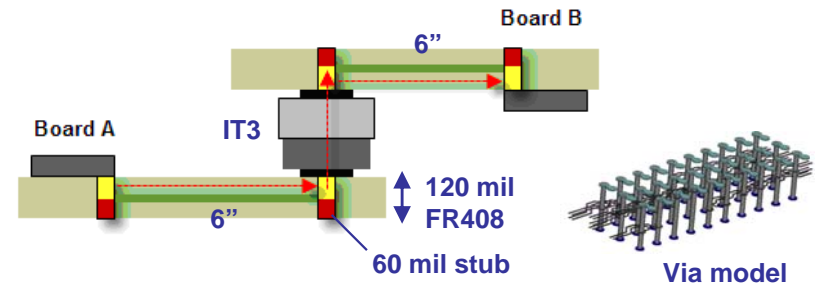
- ADS simulation with 3-tap TX equalization gives good open eyes @6.25 Gbps with ~60mil via stub and 14 FEXT included.



Without connector

Jitter = 11.64ps

Eye Height = 1024.59mV



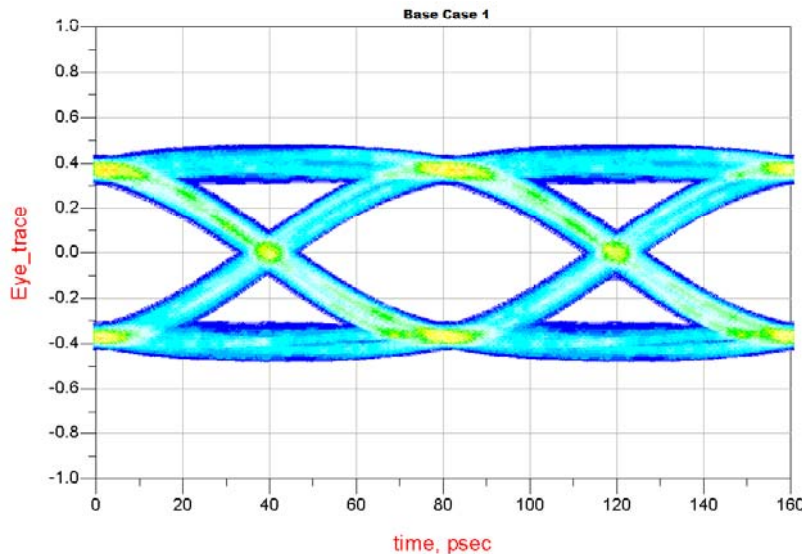
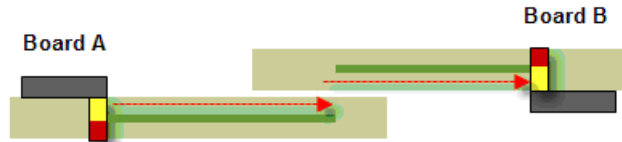
With connector and 14 FEXT

Jitter = 16.02ps

Eye Height = 898.08mV

Channel simulation @12.5 Gbps (50% density)

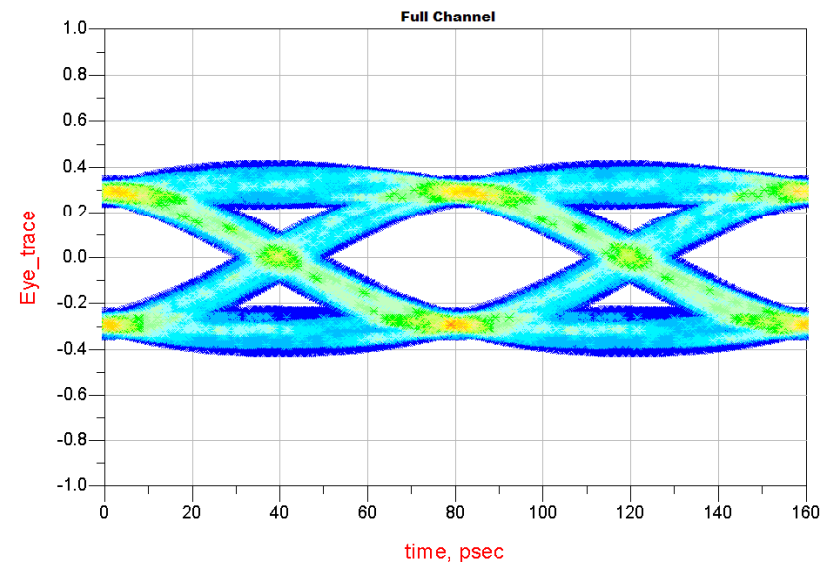
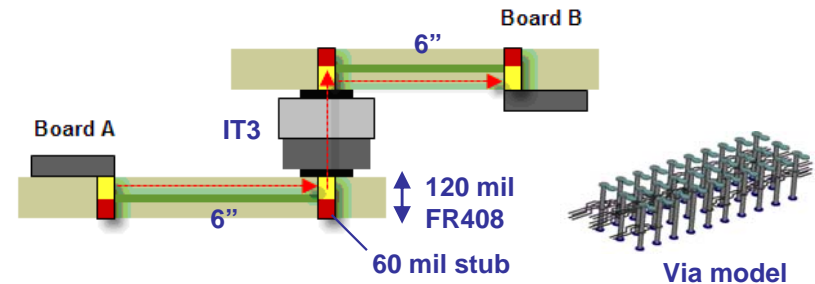
- ADS simulation with 3-tap TX equalization gives good open eyes @12.5 Gbps with ~60mil via stub and 6 FEXT included.



Without connector

Jitter = 13.84ps

Eye Height = 559.63mV



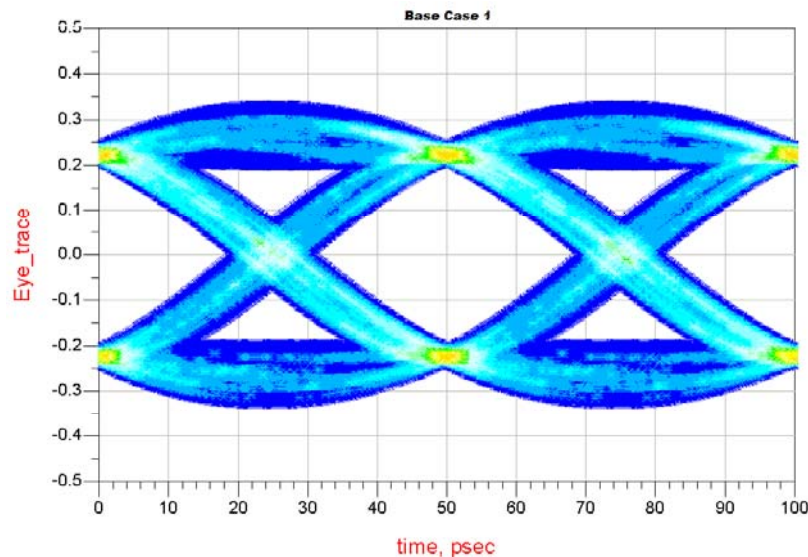
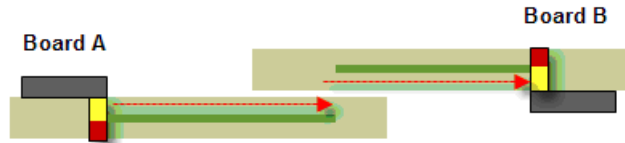
With connector and 6 FEXT

Jitter = 17.56ps

Eye Height = 476.66mV

Channel simulation @20 Gbps (50% density)

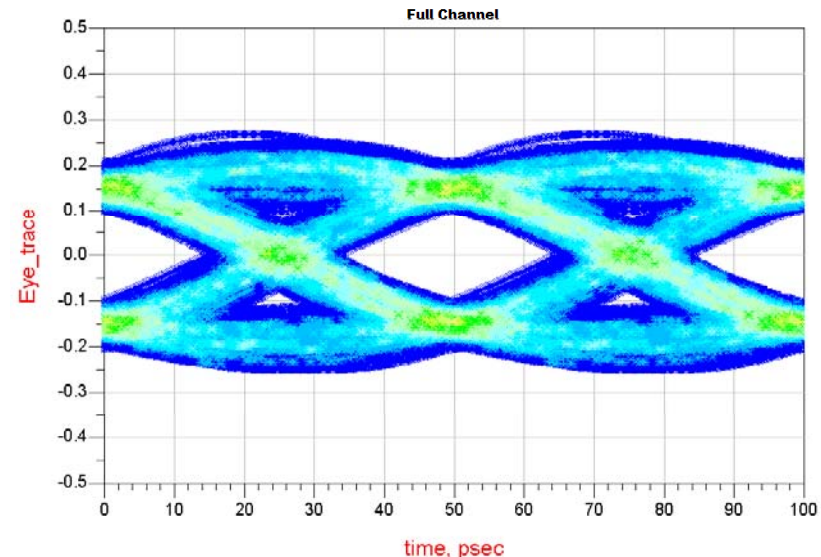
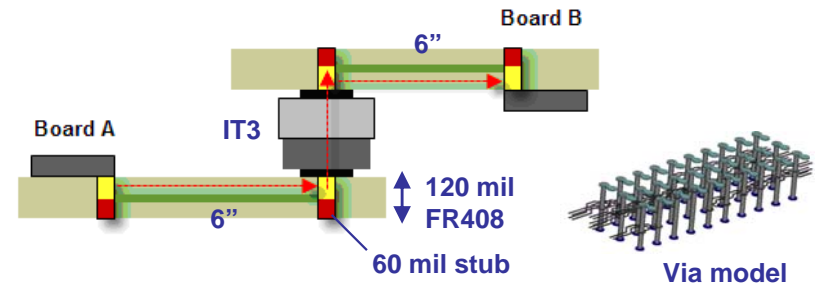
- ADS simulation with 7-tap TX equalization gives good open eyes @20 Gbps with ~60mil via stub and 6 FEXT included.



Without connector

Jitter = 15.91ps

Eye Height = 296.02mV



With connector and 6 FEXT

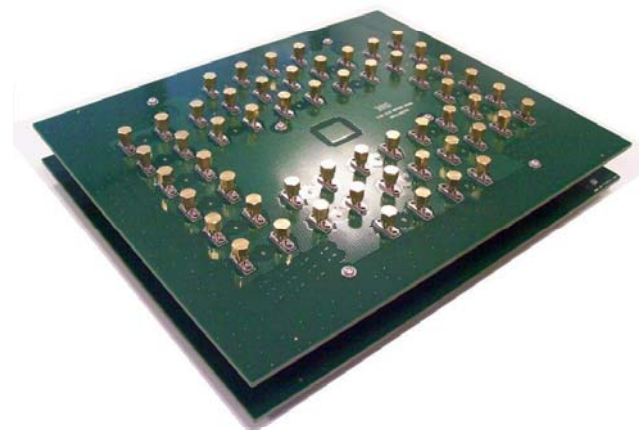
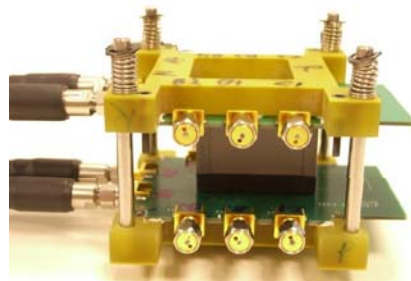
Jitter = 18.79ps*

Eye Height = 207.04mV*

*Degradation is mainly due to via stubs.

Summary

- IT3 meets the extrapolated IEEE802.3ap's ICR spec. for 20+ Gbps.
- Both characterization and demo boards are available for evaluation.



Appendix A

Measurement vs. Simulation



HIROSE ELECTRIC

Outline

- Measurement setup
 - Test samples
 - Test fixture
 - Test equipment
- Differential results
 - Insertion and return losses
 - TDR @ 60ps rise time (20%~80%)
 - Same-wafer NEXT and FEXT
 - Different-wafer NEXT and FEXT
 - Diagonal-neighbor NEXT and FEXT
 - ICR wrt. FEXT
- Summary

Test samples

- IT3-38H
 - Stacking height: 38mm
 - Part number:
 - Mating receptacle: IT3D-300S-BGA(57)
 - Interposer: IT3-300P-38H(03)
 - Mounting receptacle: IT3M-300S-BGA(57)

IT3D-300S-BGA(57)

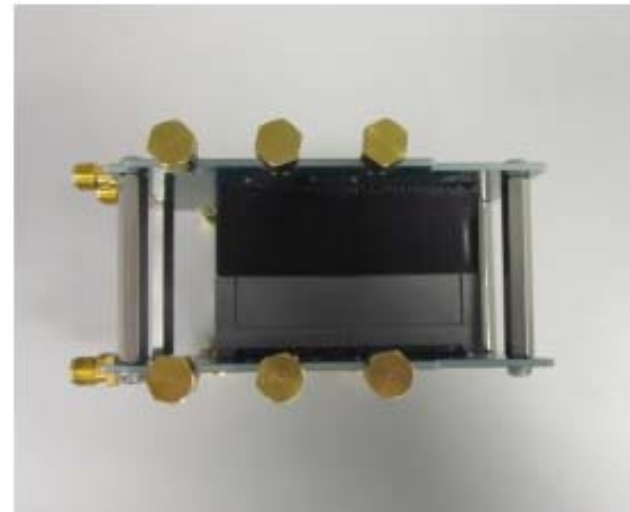
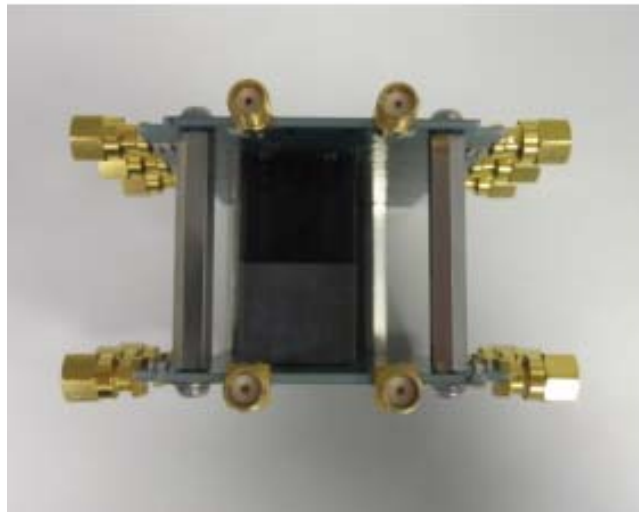
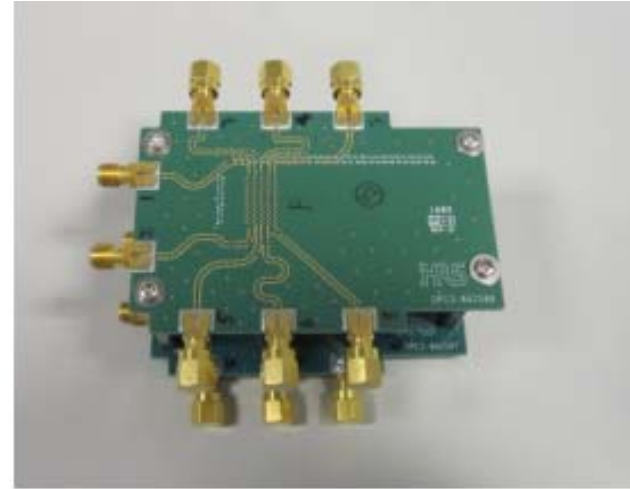
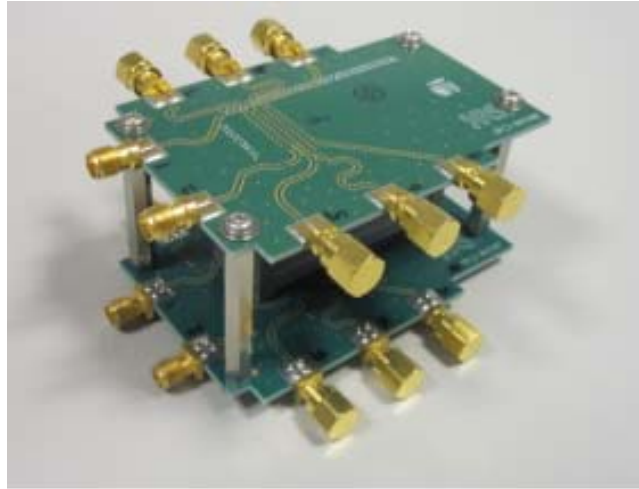
IT3-300P-38H(03)

IT3M-300S-BGA(57)



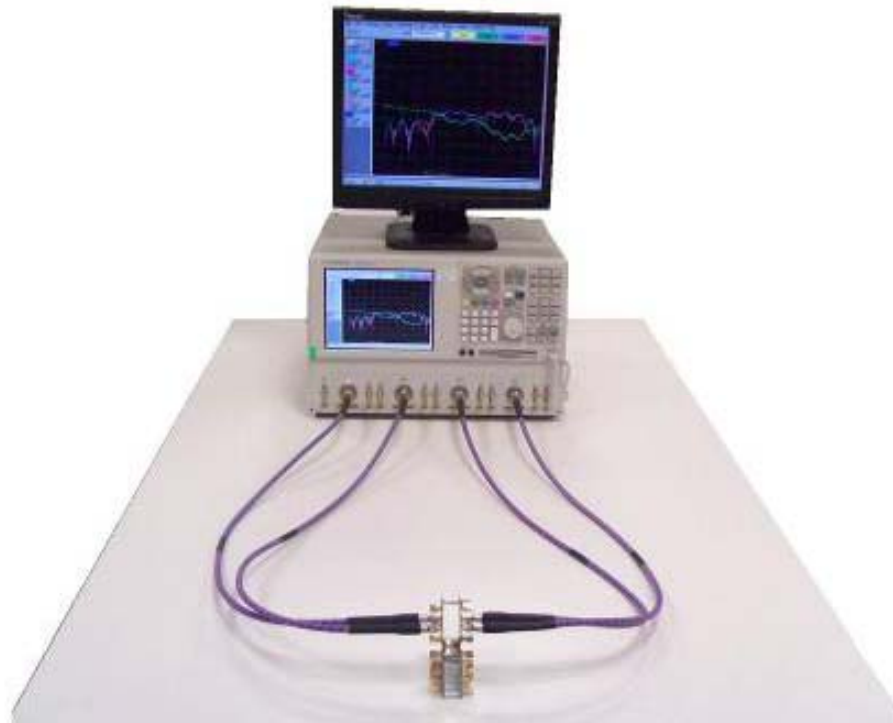
Test fixture

- IT3 was mounted on the test boards.



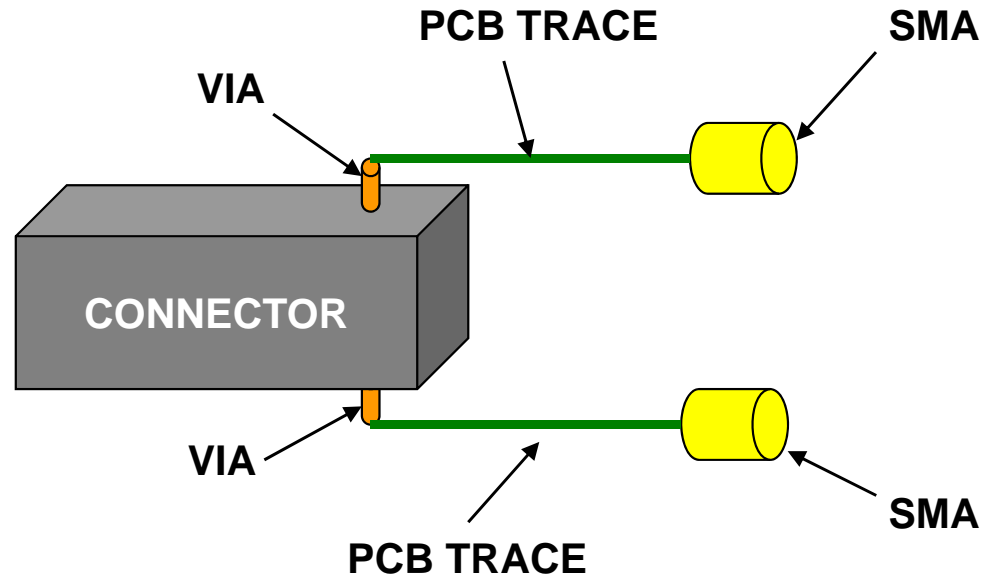
VNA setup

- IT3 was measured using a vector network analyzer (Agilent N5230A).



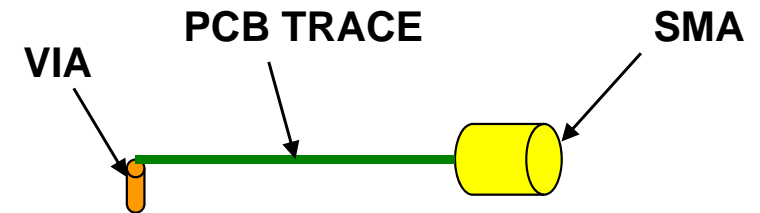
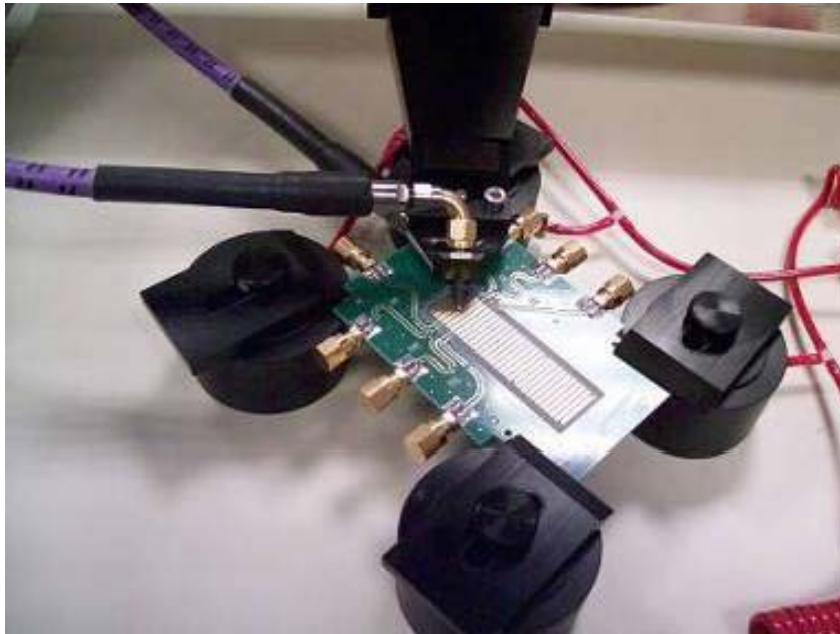
Measurements taken from SMA to SMA

- Measurements include SMA, trace, via, connector, via, trace, and SMA.



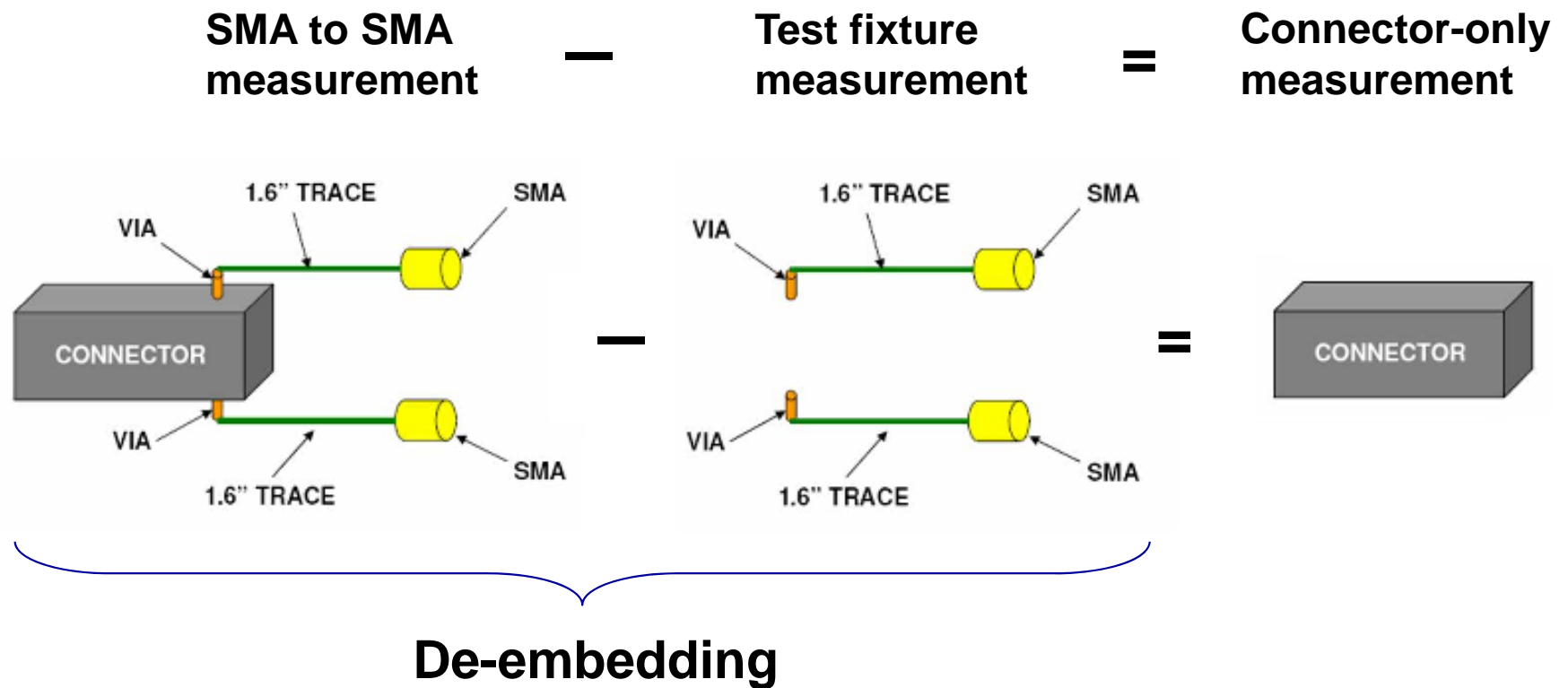
Test fixture measurement

- Bare test fixture was measured from SMA to connector footprint using VNA and probe station.
- Test fixture measurement includes SMA, trace, and via.



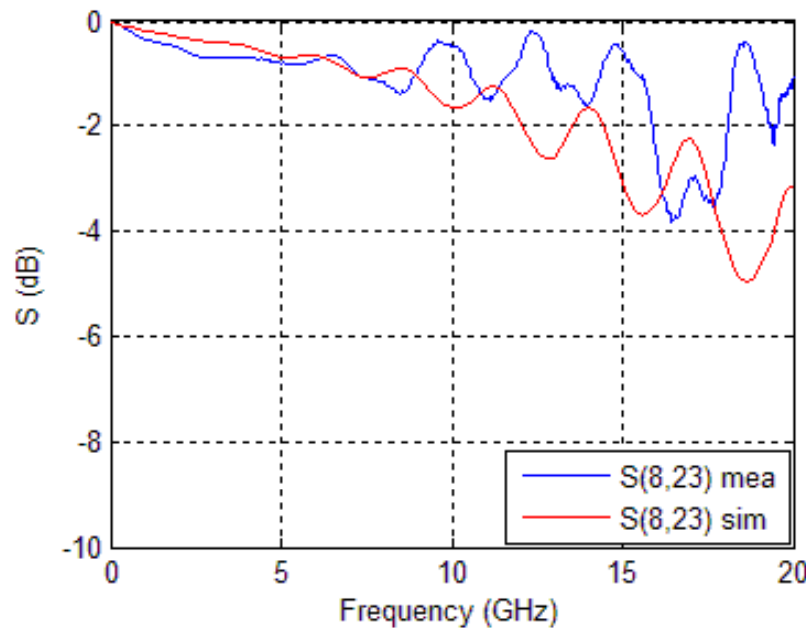
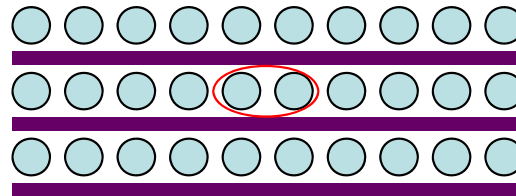
Connector only measurements

- Test fixture measurements were used to remove the effects of SMAs, traces, and vias.
- After de-embedding, the connector-only data remains.

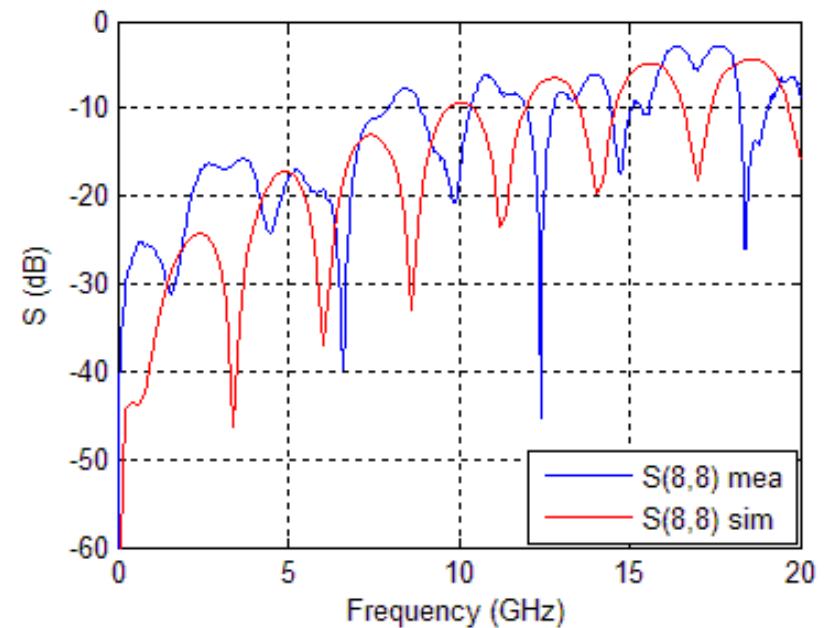


Insertion and return losses

- Good correlation* in both differential insertion and return losses.



Insertion loss

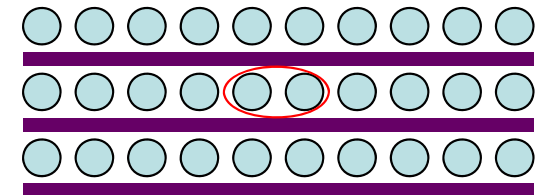
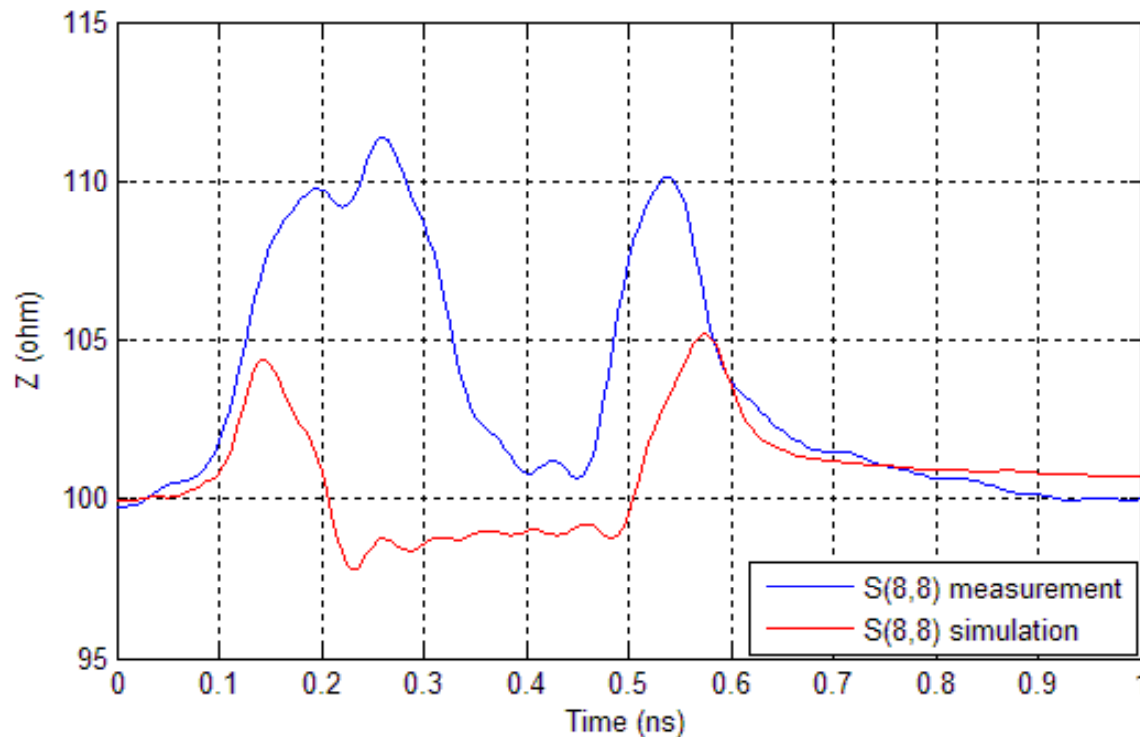


Return loss

* Measurement gives higher impedance (- see next slide).

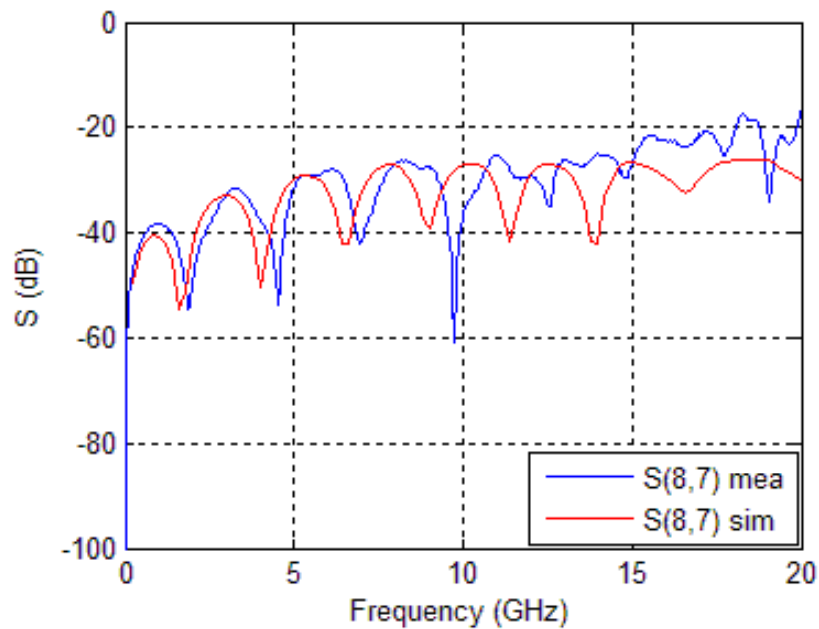
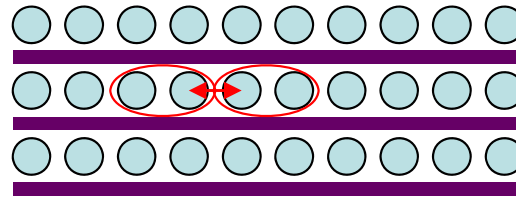
TDR @ 60ps rise time (20%~80%)

- Measured and simulated impedance profiles are comparable at 60ps rise time (20%~80%) and 5.25GHz bandwidth.

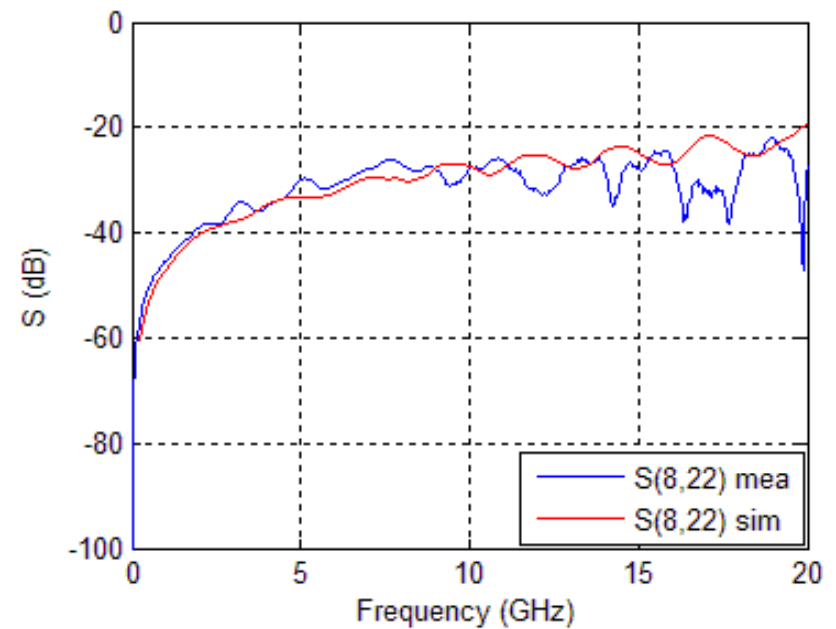


Same-wafer NEXT and FEXT

- Good correlation for the same-wafer differential NEXT and FEXT.



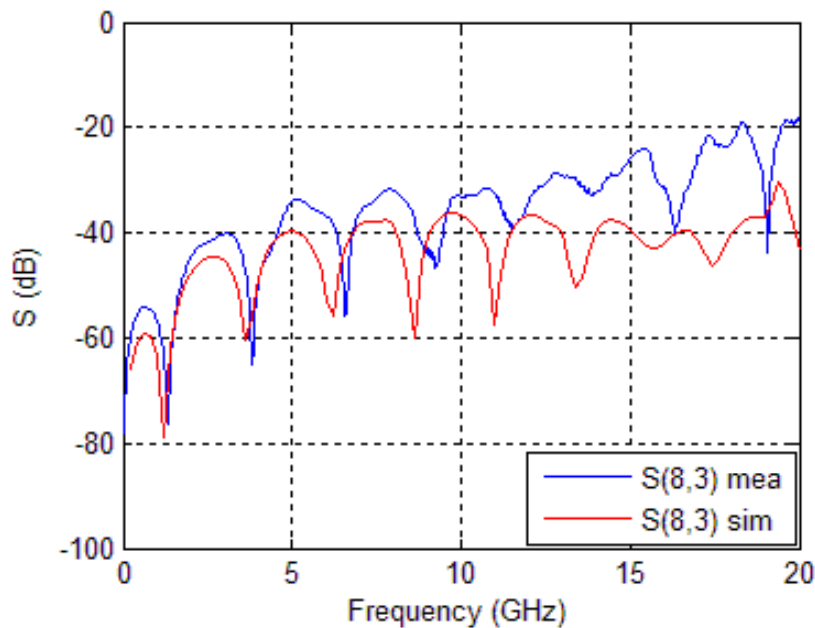
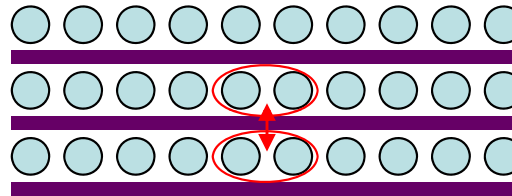
NEXT



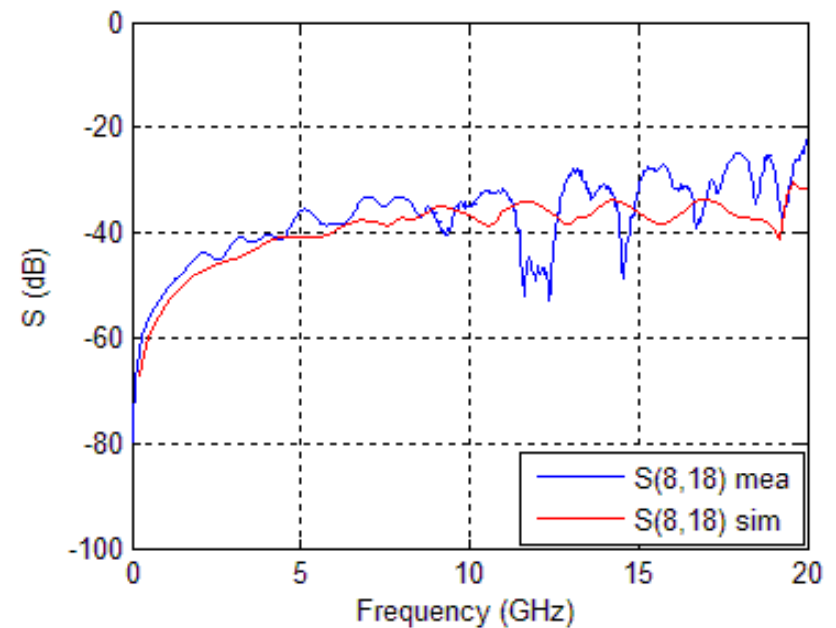
FEXT

Different-wafer NEXT and FEXT

- Good correlation for the different-wafer differential NEXT and FEXT.



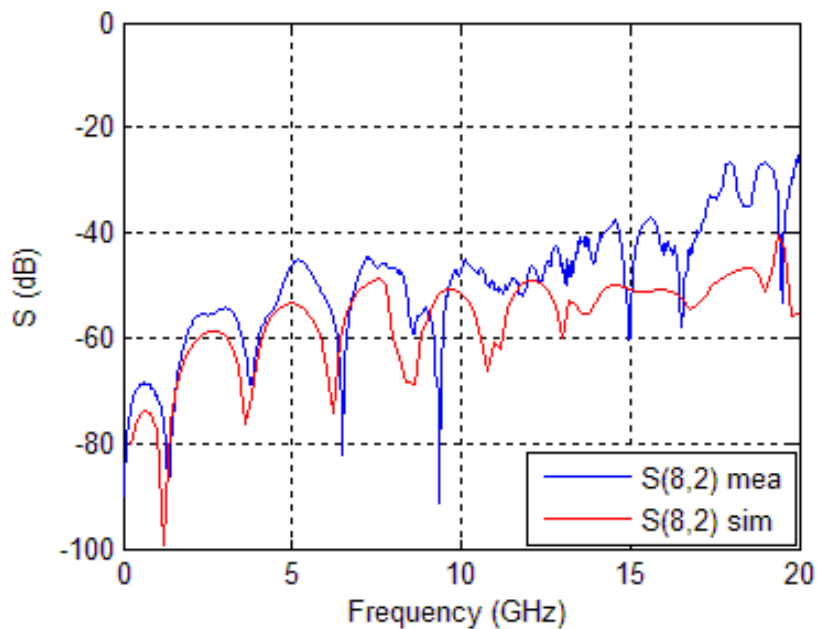
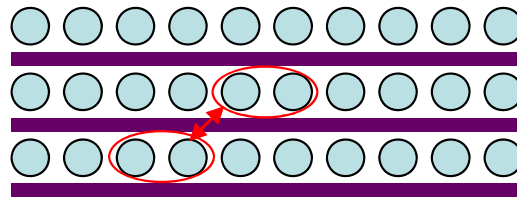
NEXT



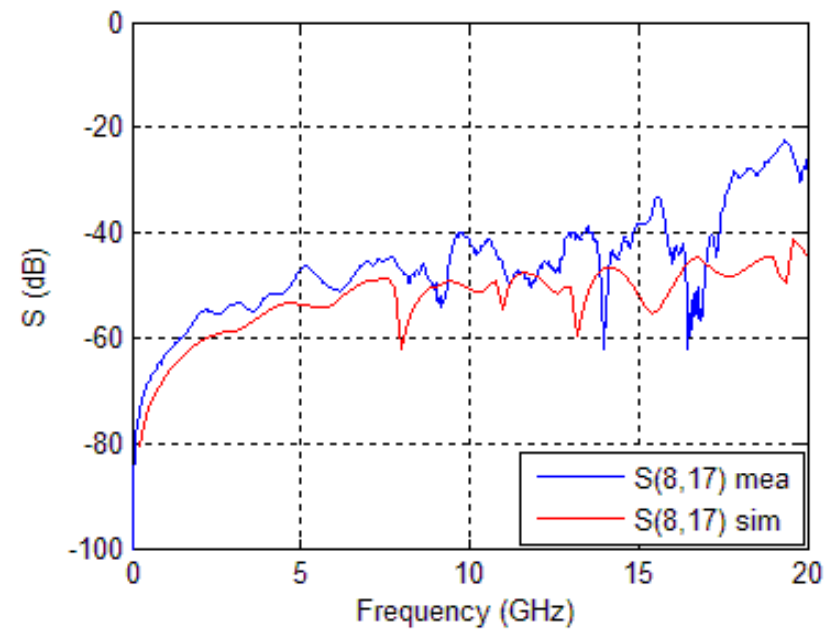
FEXT

Diagonal-neighbor NEXT and FEXT

- Good correlation* for the diagonal-neighbor differential NEXT and FEXT.



NEXT

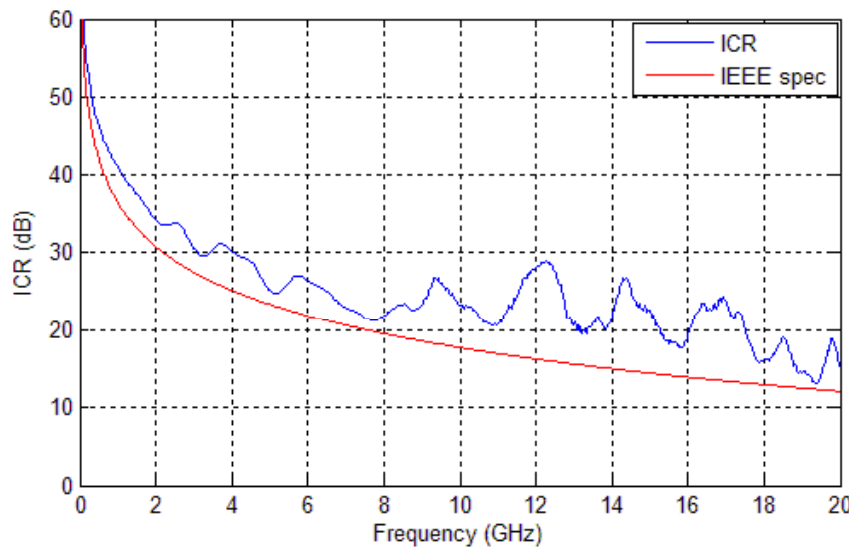
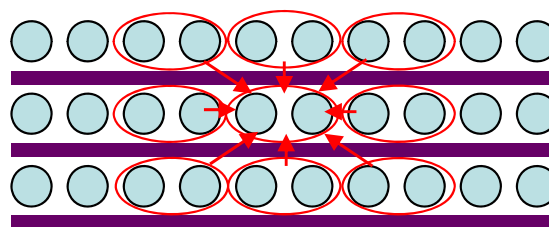


FEXT

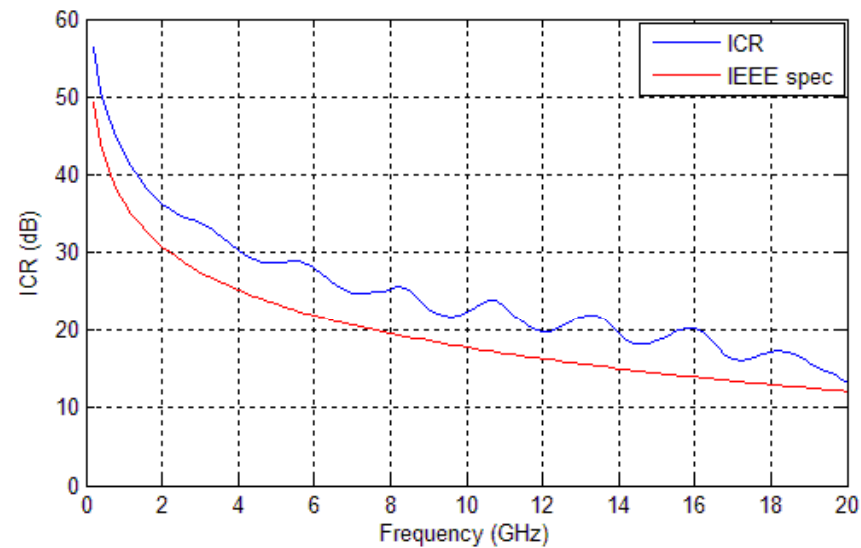
* Note that NEXT and FEXT are very small in this case.

ICR

- The insertion-loss-to-crosstalk ratio (ICR) with 8-aggressor FEXT meets the extrapolated IEEE802.3ap spec. to 10+ GHz.



Measurement



Simulation

Summary

- IT3-38mm simulation and measurement results show good correlation.
- IT3-38mm meets the extrapolated IEEE802.3ap spec. for 20+ Gbps data transmission.