The Need For a Normative Channel Model Approach

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Note – This individual supports an end-to-end normative analysis tool. This support does not imply support for the NRZ signaling scheme used in the simulation of this presentation.

Review of Tyco Channels

Test Case	Line Card		Backplane			Total Length	Comments
	Length	Material	Length	Material	Stub		
1	10" (254mm)	Nelco 4000-13SI	20" (508mm)	Nelco 4000-13SI	Bottom (or counter-boring)	40" (1016mm)	Channel Model *Tyco – Data is available.*
2	10" (254mm)	Nelco 4000-13	20" (508mm)	Nelco 4000-13SI	Bottom (or counter-boring)	40" (1016mm)	Margin Test Case *Tyco - Data is available.*
3	10" (254mm)	Nelco 4000-6	20" (508mm)	Nelco 4000-13SI	Bottom (or counter-boring)	40" (1016mm)	Margin Test Case *Tyco - Data is available.*
4	6" (152mm)	Nelco 4000-13	20" (508mm)	Nelco 4000-13SI	Bottom (or counter-boring)	32" (812mm)	ATCA Full Mesh *Tyco - Data is available.*
5	6" (152mm)	Nelco 4000-13	10" (254mm)	Nelco 4000-13	Bottom (or counter-boring)	22" (558mm)	ATCA Dual Star *Tyco - Data is available.*
6	6" (152mm)	Nelco 4000-13	10" (254mm)	Nelco 4000-13	Top Layer (with stub)	22" (558mm)	ATCA Dual Star *Tyco - Data is available.*
7	6" (152mm)	Nelco 4000-13SI	1" (25mm)	Nelco 4000-13SI	Near Top-Layer (with stub)	13" (330mm)	Adjacent Slot *Tyco - Data is available.*
NOTE: Data for all test cases includes dominant, adjacent NEXT and FEXT aggressors.							

Review of IBM Simulations

- Channels with stubs were most difficult
- Device packaging had an impact
- Simulations done using 6G IC model (ESD Diodes and load termination)

Case 5 with Organic Package

Simulation Results* (opening at 10^{-12} BER)

	FFE2	FFE3	FFE4
DFE0	5.7%	9.5%	20.2%
DFE1	9.8%	21.1%	9.8%
DFE2	12.2%	17.4%	9.7%
DFE3	16.0%	18.9%	15.4%
DFE4	18.8%	23.1%	12.2%
DFE5	21.3%	22.2%	10.4%

Case 6 with Organic Package

Simulation Results* (opening at 10^{-12} BER)

	FFE2	FFE3	FFE4
DFE0	e-3	e-4	e-6
DFE1	e-8	0%	e-11
DFE2	e-8	0%	0%
DFE3	e-8	0%	2.8%
DFE4	e-9	4.6%	3.4%
DFE5	e-11	5.5%	8.4%

Case 7 with Organic Package

Simulation Results* (opening at 10^{-12} BER)

	FFE2	FFE3	FFE4
DFE0	e-5	e-5	e-6
DFE1	e-9	0.1%	0%
DFE2	e-11	4.6%	3.8%
DFE3	0.1%	4.4%	4.8%
DFE4	6.2%	6.2%	12.1%
DFE5	10.9%	9.7%	9.7%

Case 5 with Plastic Package

Simulation Results* (opening at 10^{-12} BER)

	FFE2	FFE3	FFE4
DFE0	e-6	e-7	11.2%
DFE1	9.7%	15.7%	17.1%
DFE2	9.7%	15.0%	17.1%
DFE3	14.6%	16.7%	15.2%
DFE4	16.5%	15.8%	20.9%
DFE5	20.8%	15.5%	21.1%

Case 6 with Plastic Package

Simulation Results* (opening at 10^{-12} BER)

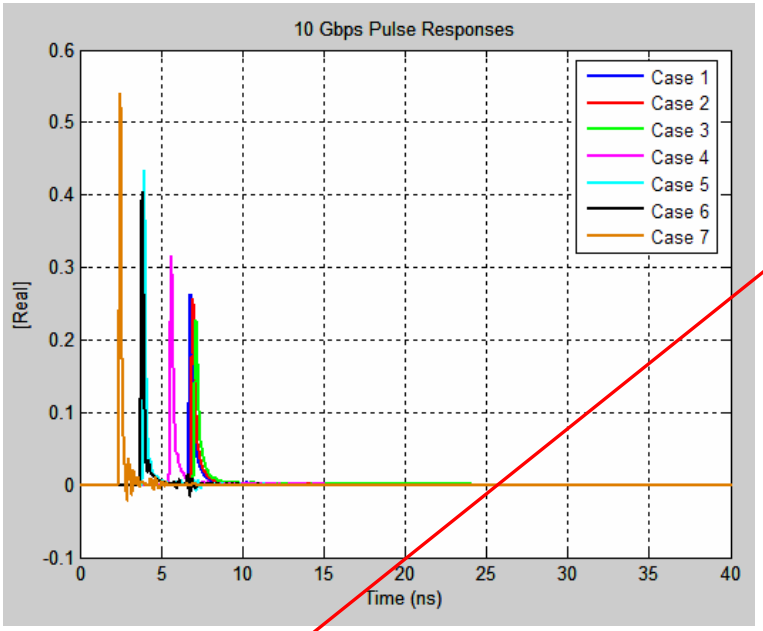
	FFE2	FFE3	FFE4
DFE0	e-3	e-3	e-4
DFE1	e-7	0%	e-9
DFE2	e-8	0%	e-11
DFE3	e-8	4.1%	0.1%
DFE4	e-10	4.4%	0%
DFE5	0%	4.6%	3.9%

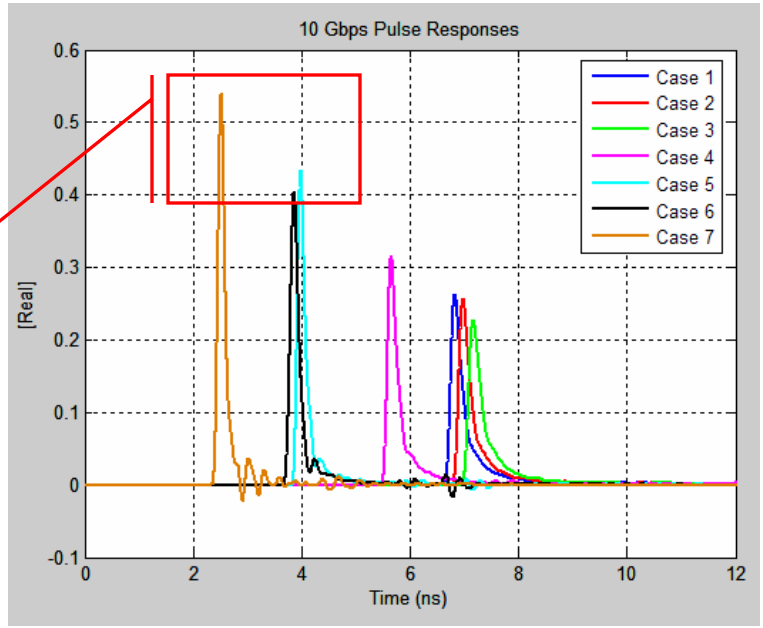
Case 7 with Plastic Package

Simulation Results* (opening at 10^{-12} BER)

	FFE2	FFE3	FFE4
DFE0	e-4	e-4	e-5
DFE1	e-11	e-9	0.4%
DFE2	e-9	0.4%	5.4%
DFE3	4.1%	1.7%	3.9%
DFE4	1.5%	4.7%	5.8%
DFE5	5.9%	3.8%	4.2%

Pulse Reponse of All Tyco Channels

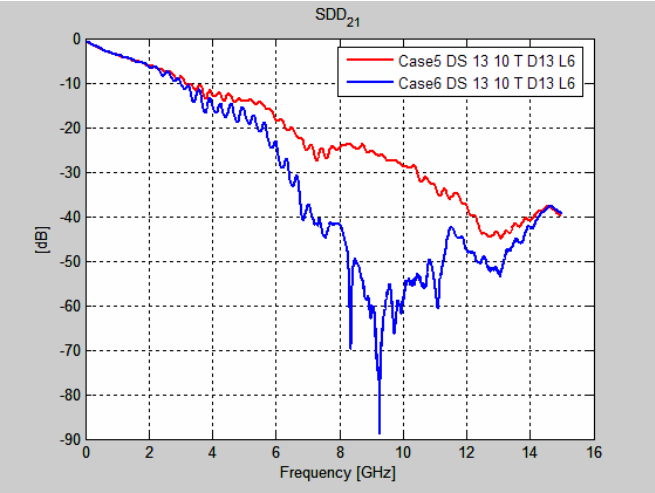


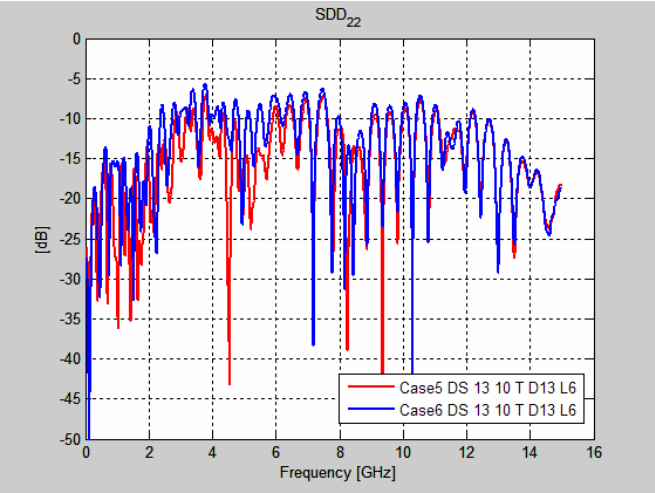


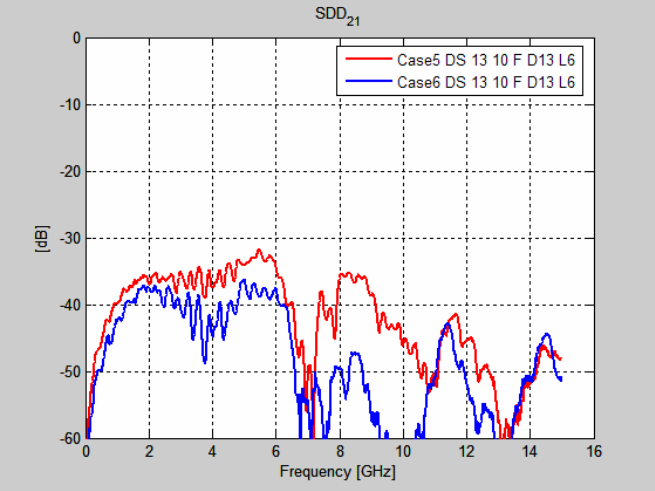
Note – The two most difficult channels had the greatest peak

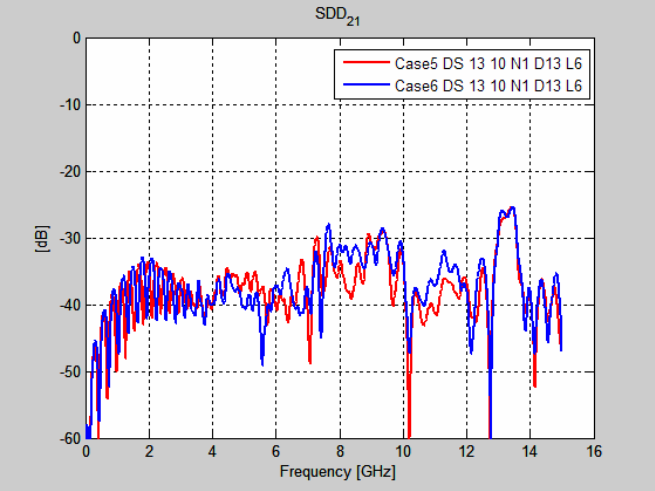
Let's look at Cases #5 and #6

Cases #5 and #6
Frequency Characterization









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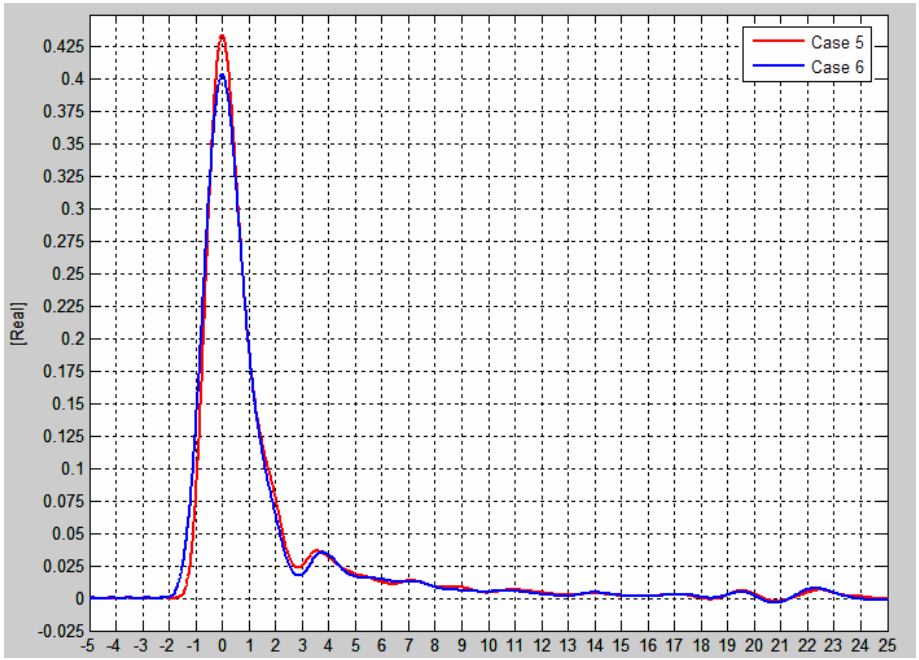
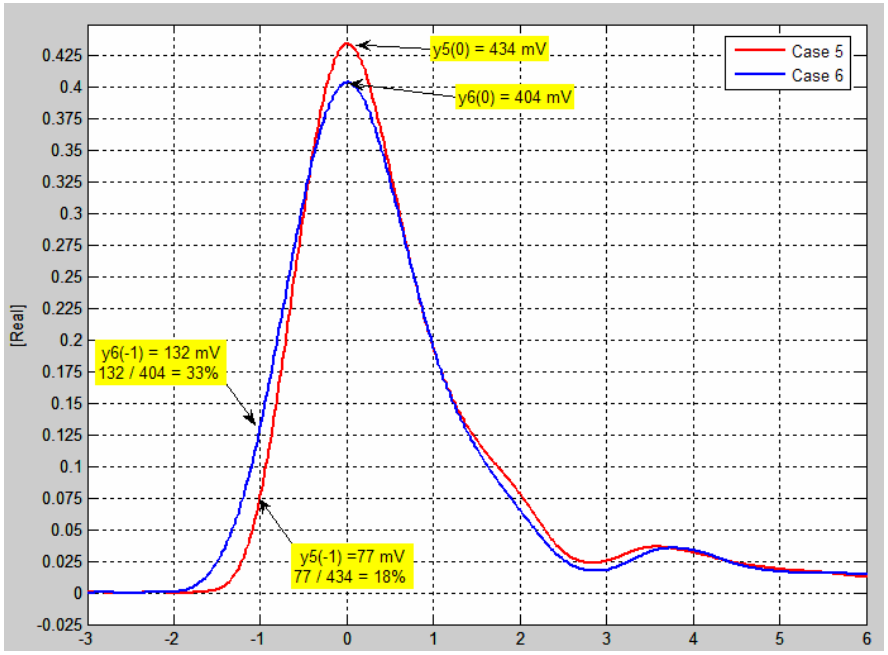
Cases #5 and #6 TP1-4 Pulse Response





Case #6 vs Case #5

- 7% Reduction in peak (but still larger than other signals)
- 15% increase in t(-1) contribution
- Little different in tail

Additional Simulations for Cases #5 and #6

	Case 5 FFE3/DFE3	Case 5 FFE3/DFE5	Case 6 FFE3/DFE3	Case 6 FFE3/DFE5
1. Original results	18.9%	22.2%	0% (BER floor at E-12)	5.5%
2. No Packaging	15.7%	17.1%	<0 (BER floor at E-8)	<0 (BER floor at E-11)
3. No Packaging, No IC	27.4%	27.0%	16.5%	19.9%
4. No Packaging, No IC, No Xtalk	32.9%	33.0%	20.8%	22.1%

Simulation 1 – Original simulations, as specified in abler_01_00904.pdf

Simulation 2 – As stated in Simulation #1, except packaging removed

Simulation 3 – As stated in Simulation #2, except IC Model (ESD and load structures) replaced with perfect 50Ω terminations.

Simulation 4 – As stated in Simulation #3, except all crosstalk removed

Conclusions

- Case #5 vs Case #6 Frequency Behavior
  - SDD21 – classic stub effect comparison
  - ***SDD22 – very similar***
  - NEXT – higher for Case #5
  - FEXT – similar
  - Pulse behavior similar except t(-1)
- Case #5 Simulations
  - No package – decreased opening, suspect less attenuation of reflections
  - No IC model – eliminates reflections, largest contributor to increasing eye opening
  - No xtalk – approximate 6% improvement
- Case #6 Simulations
  - No package – decreased opening, suspect less attenuation of reflections
  - No IC model – eliminates reflections, largest contributor to increasing eye opening
  - No xtalk – approximate 2% to 4% improvement

- Simulations were done using 6G IC model (ESD Diodes and load termination). Improved IC return loss should yield better results.

Recommendations

- Throughput "typical" comparison point, but predicted perfomance is a ***system issue***
- Reflections are driven by a number of factors
  - Tx Launched Signal
  - Channel (TP1 / TP4) throughput
  - Channel (TP1 / TP4) return loss
  - Device return loss
  - Package and IC (ESD / termination) effects
- A synergistic view point is necessary, so a normative end-to-end analysis tool is needed
- Future analysis will need to include effects of AC coupling cap.