

June, 2005

Informative Model / Simulation Comparisons for 10GBASE-KR

John D'Ambrosia
Tyco Electronics

Conditions

- ILmin (per mellitz_02_0605).
- Amin (use f1 / f2 per mellitz_02_0605).
- Positive Peak Deviation (per mellitz_02_0605).
- Negative Peak Deviation (per mellitz_02_0605).
- ICR $ICR(dB) \geq 12.5 - 20 \log_{10} \left(\frac{f}{5GHz} \right), f = 0.1...5GHz$

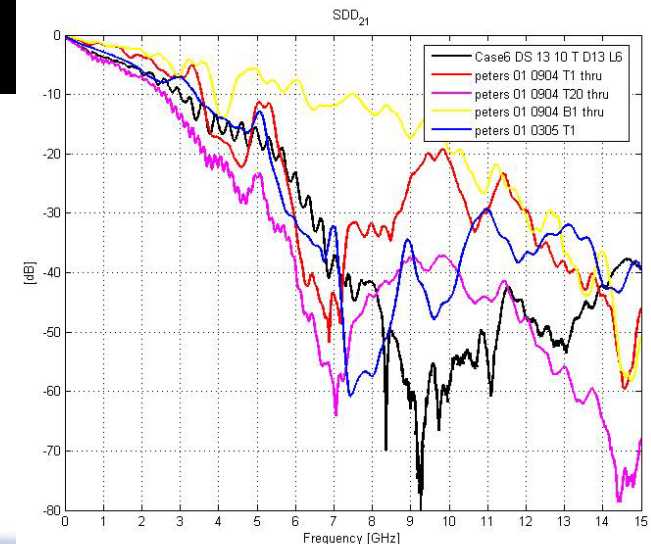
	>Imin	> Amin	Positive Peak Deviation	Negative Peak Deviation	ICR	Prediction	
						No ICR	With ICR
Tyco Case #1	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tyco Case #2	Pass	Pass	Pass	Pass	Fail	Pass	Fail
Tyco Case #3	Pass	Fail	Pass	Pass	Pass	Fail	Fail
Tyco Case #4	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tyco Case #5	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tyco Case #6	Fail	Pass	Pass	Pass	Pass	Fail	Fail
Tyco Case #7	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Molex In2	Pass	Pass	Pass	Pass	Fail	Pass	Fail
Molex In3	Pass	Pass	Pass	Pass	Fail	Pass	Fail
Molex In4	Pass	Pass	Pass	Pass	Fail	Pass	Fail
Molex In5	Pass	Pass	Pass	Pass	Fail	Pass	Fail
Molex Out2	Pass	Pass	Pass	Pass	Fail	Pass	Fail
Molex Out3	Pass	Pass	Pass	Pass	Fail	Pass	Fail
Molex Out4	Pass	Pass	Pass	Pass	Fail	Pass	Fail
Molex Out5	Pass	Pass	Pass	Pass	Fail	Pass	Fail
0904_Intel T1	Fail	Pass	Fail	Fail	Fail	Fail	Fail
0904_Intel T12	Fail	Pass	Pass	Fail	Fail	Fail	Fail
0904_Intel T20	Fail	Fail	Pass	Fail	Fail	Fail	Fail
0904_Intel M1	Pass	Pass	Pass	Pass	Pass	Pass	Pass
0904_Intel M20	Pass	Pass	Pass	Pass	Fail	Pass	Fail
0904_Intel B1	Pass	Pass	Pass	Fail	Pass	Fail	Fail
0904_Intel B12	Pass	Pass	Pass	Pass	Pass	Pass	Pass
0904_Intel B20	Pass	Pass	Pass	Pass	Fail	Pass	Fail
0305_Intel T1	Fail	Pass	Pass	Pass	Fail	Fail	Fail
0305_Intel T12	Fail	Pass	Pass	Pass	Fail	Fail	Fail
0305_Intel T20	Fail	Pass	Pass	Pass	Fail	Fail	Fail
0305_Intel M1	Pass	Pass	Pass	Pass	Fail	Pass	Fail
0305_Intel M20	Pass	Pass	Pass	Pass	Fail	Pass	Fail
0305_Intel B1	Pass	Pass	Pass	Pass	Fail	Pass	Fail
0305_Intel B12	Pass	Pass	Pass	Pass	Fail	Pass	Fail
0305_Intel B20	Pass	Pass	Pass	Pass	Fail	Pass	Fail

	IBM 10 [^] -12, no Xtalk	IBM 10 [^] -12	Brink 10 [^] -12	Altmann 10 [^] -12	IBM 10% @ 10 [^] -12	Brink 10% @ 10 [^] -12	Altmann 10% @ 10 [^] -12	Actual (majority wins)		
								10 [^] -12 no xtalk	10 [^] -12	10 [^] -12 Margin
Tyco Case #1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tyco Case #2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tyco Case #3	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Tyco Case #4	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tyco Case #5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tyco Case #6	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Tyco Case #7	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Molex In2	Pass	Pass			Fail			Pass	Pass	Fail
Molex In3	Pass	Fail			Fail			Pass	Fail	Fail
Molex In4	Pass	Fail			Fail			Pass	Fail	Fail
Molex In5	Pass	Pass			Fail			Pass	Pass	Fail
Molex Out2	Pass	Pass			Pass			Pass	Pass	Pass
Molex Out3	Pass	Pass			Fail			Pass	Pass	Fail
Molex Out4	Pass	Pass			Fail			Pass	Pass	Fail
Molex Out5	Pass	Pass			Pass			Pass	Pass	Pass
0904_Intel T1	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail
0904_Intel T12	Fail	Fail	Fail		Fail	Fail		Fail	Fail	Fail
0904_Intel T20	Pass	Fail	Fail		Fail	Fail		Pass	Fail	Fail
0904_Intel M1	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Fail
0904_Intel M20	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Fail
0904_Intel B1	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Fail
0904_Intel B12	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
0904_Intel B20	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
0305_Intel T1	Pass	Fail			Fail			Pass	Fail	Fail
0305_Intel T12	Pass	Fail			Fail			Pass	Fail	Fail
0305_Intel T20	Pass	Fail			Fail			Pass	Fail	Fail
0305_Intel M1		Pass			Pass				Pass	Pass
0305_Intel M20		Pass			Pass				Pass	Pass
0305_Intel B1		Pass			Pass				Pass	Pass
0305_Intel B12		Pass			Pass				Pass	Pass
0305_Intel B20		Pass			Pass				Pass	Pass

	IBM 10 ⁻¹² , no Xtalk	>Imin	> Amin	Positive Peak Deviation	Negative Peak Deviation	Prediction No ICR	Actual (majority wins) 10 ⁻¹² no xtalk	10 ⁻¹² No Xtalk, No ICR
Tyco Case #1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #3	Pass	Pass	Fail	Pass	Pass	Fail	Pass	FN
Tyco Case #4	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #6	Pass	Fail	Pass	Pass	Pass	Fail	Pass	FN
Tyco Case #7	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex In2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex In3	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex In4	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex In5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex Out2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex Out3	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex Out4	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex Out5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
0904_Intel T1	Fail	Fail	Pass	Fail	Fail	Fail	Fail	Y
0904_Intel T12	Fail	Fail	Pass	Pass	Fail	Fail	Fail	Y
0904_Intel T20	Pass	Fail	Fail	Pass	Fail	Fail	Pass	FN
0904_Intel M1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
0904_Intel M20	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
0904_Intel B1	Pass	Pass	Pass	Pass	Fail	Fail	Pass	FN
0904_Intel B12	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
0904_Intel B20	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
0305_Intel T1	Pass	Fail	Pass	Pass	Pass	Fail	Pass	FN
0305_Intel T12	Pass	Fail	Pass	Pass	Pass	Fail	Pass	FN
0305_Intel T20	Pass	Fail	Pass	Pass	Pass	Fail	Pass	FN
0305_Intel M1		Pass	Pass	Pass	Pass	Pass		
0305_Intel M20		Pass	Pass	Pass	Pass	Pass		
0305_Intel B1		Pass	Pass	Pass	Pass	Pass		
0305_Intel B12		Pass	Pass	Pass	Pass	Pass		
0305_Intel B20		Pass	Pass	Pass	Pass	Pass		

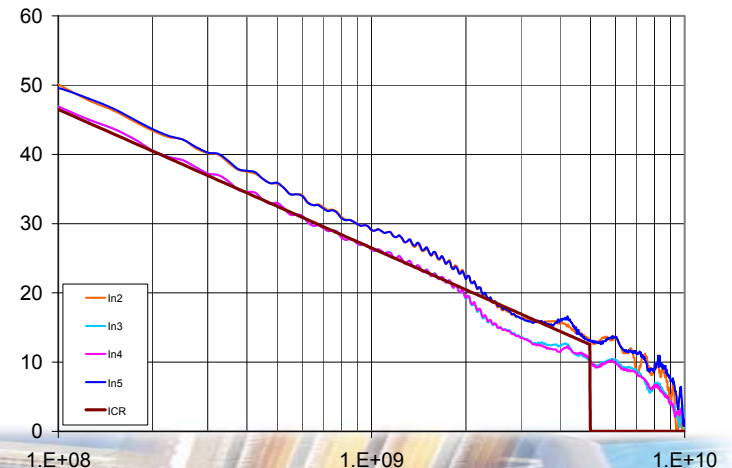
Model Prediction with no Crosstalk

- 26 test cases (only IBM simulations). 24 pass simulations (Criteria – BER < 10⁻¹²)
- All failures (2) identified, 7 false negatives
- If failing a single criteria is the measure (as above without noise) then there are 7 false negatives
- If failing any two criteria is the measure then there is one false negative, however, for all the possible cases it could depend on how bad a single failure is.



	>IImIn	> Amin	Positive Peak Deviation	Negative Peak Deviation	ICR	Prediction With ICR	Actual (majority wins) 10 ⁻¹²	Prediction vs Actual 10 ⁻¹²
Tyco Case #1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #2	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
Tyco Case #3	Pass	Fail	Pass	Pass	Pass	Fail	Pass	False Negative
Tyco Case #4	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #6	Fail	Pass	Pass	Pass	Pass	Fail	Pass	False Negative
Tyco Case #7	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex In2	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
Molex In3	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Y
Molex In4	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Y
Molex In5	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
Molex Out2	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
Molex Out3	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
Molex Out4	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
Molex Out5	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0904_Intel T1	Fail	Pass	Fail	Fail	Fail	Fail	Fail	Y
0904_Intel T12	Fail	Pass	Pass	Fail	Fail	Fail	Fail	Y
0904_Intel T20	Fail	Fail	Pass	Fail	Fail	Fail	Fail	Y
0904_Intel M1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
0904_Intel M20	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0904_Intel B1	Pass	Pass	Pass	Fail	Pass	Fail	Pass	False Negative
0904_Intel B12	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
0904_Intel B20	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel T1	Fail	Pass	Pass	Pass	Fail	Fail	Fail	Y
0305_Intel T12	Fail	Pass	Pass	Pass	Fail	Fail	Fail	Y
0305_Intel T20	Fail	Pass	Pass	Pass	Fail	Fail	Fail	Y
0305_Intel M1	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel M20	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel B1	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel B12	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel B20	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative

- 31 test cases. 23 pass simulations. (Criteria – BER < 10⁻¹²)
- All failures (8) identified, 17 false negatives
- Six of the eight “true” failures failed ICR plus another criteria.
- All false negatives only failed one criteria.
- Failing ICR alone could either be a true fail or a false negative. Depends on the severity of the failure.
- Molex In2, In5, Out2, Out5 examples of single aggressor and imply single aggressor ICR can be used.



	>Imin	> Amin	Positive Peak Deviation	Negative Peak Deviation	ICR	Prediction With ICR	Actual (majority wins 10 ⁻¹² Margin)	Prediction vs Actual 10 ⁻¹² Margin
Tyco Case #1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #2	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
Tyco Case #3	Pass	Fail	Pass	Pass	Pass	Fail	Pass	False Negative
Tyco Case #4	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Tyco Case #6	Fail	Pass	Pass	Pass	Pass	Fail	Pass	False Negative
Tyco Case #7	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
Molex In2	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Y
Molex In3	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Y
Molex In4	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Y
Molex In5	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Y
Molex Out2	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
Molex Out3	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Y
Molex Out4	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Y
Molex Out5	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0904_Intel T1	Fail	Pass	Fail	Fail	Fail	Fail	Fail	Y
0904_Intel T12	Fail	Pass	Pass	Fail	Fail	Fail	Fail	Y
0904_Intel T20	Fail	Fail	Pass	Fail	Fail	Fail	Fail	Y
0904_Intel M1	Pass	Pass	Pass	Pass	Pass	Pass	Fail	False Positive
0904_Intel M20	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Y
0904_Intel B1	Pass	Pass	Pass	Fail	Pass	Fail	Fail	Y
0904_Intel B12	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Y
0904_Intel B20	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel T1	Fail	Pass	Pass	Pass	Fail	Fail	Fail	Y
0305_Intel T12	Fail	Pass	Pass	Pass	Fail	Fail	Fail	Y
0305_Intel T20	Fail	Pass	Pass	Pass	Fail	Fail	Fail	Y
0305_Intel M1	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel M20	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel B1	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel B12	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative
0305_Intel B20	Pass	Pass	Pass	Pass	Fail	Fail	Pass	False Negative

- 31 test cases. 16 pass simulations. (Criteria – BER < 10⁻¹² with 10% horizontal margin)
- All failures (15) identified, 11 false negatives, 1 false positive (but that case meets 10⁻¹²)
- 8 of the 15 “true” failures failed only ICR. 1 failure was Negative Peak Deviation. 6 other failures failed ICR plus 1 or more other parameters
- All false negatives only failed one criteria.
- Failing ICR alone could either be a true fail or a false negative. Depends on the severity of the failure.

Conclusions –

- For forward channel response
 - Failing a single parameter does not imply failure, as all false negative cases only failed a single parameter (I_{lmin}, A_{min}, Negative Peak Variation, Positive Peak variation)
 - Failing two or more parameters (I_{lmin}, A_{min}, Negative Peak Variation, Positive Peak variation) will be a failure
 - Informative model identified two failures.

Conclusions

- With Crosstalk
 - Failing the ICR by itself did not mean the channel would not meet $\text{BER} < 10^{-12}$, as it was dependent on the severity of the ICR failure.
 - For all cases - failing the ICR plus one other parameter meant the channel did not meet $\text{BER} < 10^{-12}$
 - All 6 cases that met all channel requirements worked at least to $\text{BER} < 10^{-12}$. 5 of the 6 channels worked to $\text{BER} < 10^{-12}$ plus 10% horizontal margin.
 - 17/23 channels met $\text{BER} < 10^{-12}$, failing one parameter (14 – ICR).
 - 11/16 channels met $\text{BER} < 10^{-12}$ with 10% margin failing one parameter (8 – ICR)
 - Informative model identified all 8 failures for $\text{BER} < 10^{-12}$ with no margin and 14/15 failures for $\text{BER} < 10^{-12}$ with 10% margin.

Recommendations

- Use proposed Informative parameters.
- Provide following guidance in use of informative model
 - Meeting all parameters gives high confidence of meeting $BER < 10^{-12}$.
 - Failing a single parameter does not imply that the channel will not support $BER < 10^{-12}$.
 - Failing two parameters implies that the channel will not support 10^{-12} .
- Modify single aggressor talk limit to be single aggressor ICR and use same ICR equation.