Closing the Pmax to Vf ratio budget hole

Mike Dudek QLogic
Tao Hu QLogic

IEEE 802.3by Presented at ad hoc 2/10/16

Introduction

- **Dudek_3by_01_0116 showed that there is a hole in the backplane and copper cable budgets due to the Tx specifications for Pmax to Vf ratio being more relaxed than the effective value for this ratio used in the COM transmitter for the cable/backplane channel test.**
- **The presentation was in support of comments # i-55 and i-60 against draft 3.0 which suggested that the Tx specifications should be tightened to match the value used for testing the channel. These comments were rejected with the response.**

  REJECT.

  There is not sufficient consensus to resolve at this meeting.

- **There was a feeling that the proposed solution was too stringent on the Tx and that a compromise should be made that "shared the pain" between the Tx and the channel.**
- **This presentation investigates the Trade off between this parameter and Channel COM.**

Methodology

- The COM channel up to the Tx test points was duplicated as close as possible in ADS
- The output waveform at the test point was generated using an ADS Tx with the amplitude matching the amplitude used in COM and using a very fast risetime as is used in COM.
- The resulting waveform was then analyzed using the Tx test methodology to determine the Pmax to Vf ratio
- Three different methods were then used to degrade the Tx to reduce this ratio.
  - Risetime – A trapezoidal risetime is used. Advantage – easiest to understand. Disadvantage requires COM code modification to change the risetime.
  - Package Length (pkglen). The Tx package length is increased. (Advantage – no Change to COM code. Disadvantage – increases the reflection time within the package).
  - Gamma - The loss of the package is increased for just the Tx. (Advantage- no increase in reflection time. Disadvantage - COM code needs modification to have different Gamma factors for the Tx and Rx.

Methodology (cont)

- **COM is calculated for a number of different channels as a function of the Pmax to Vf ratio for the different degradation methods.**

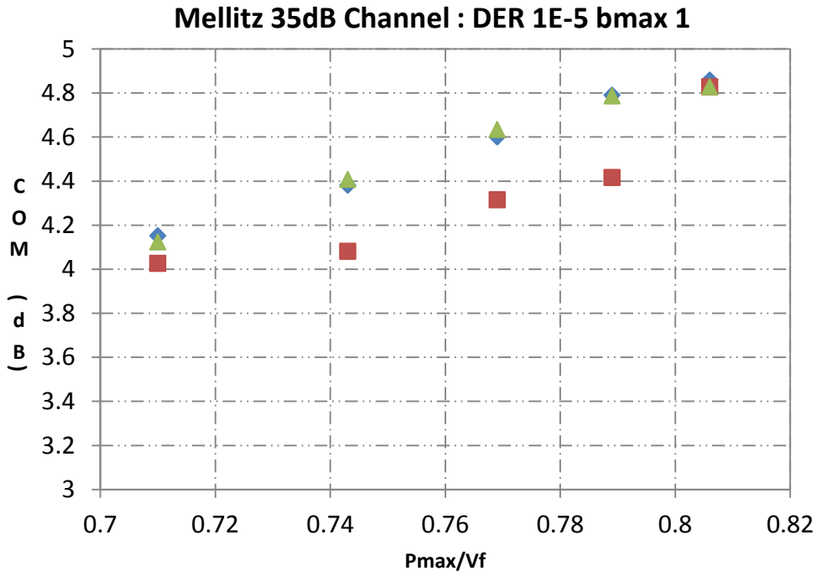
Backplane results

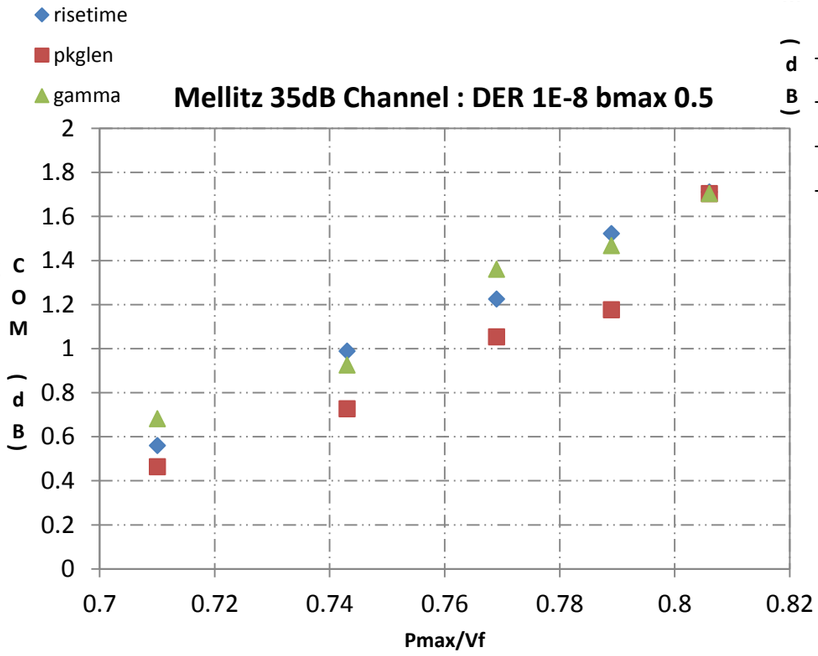
Transmitter Characteristics at TP0a

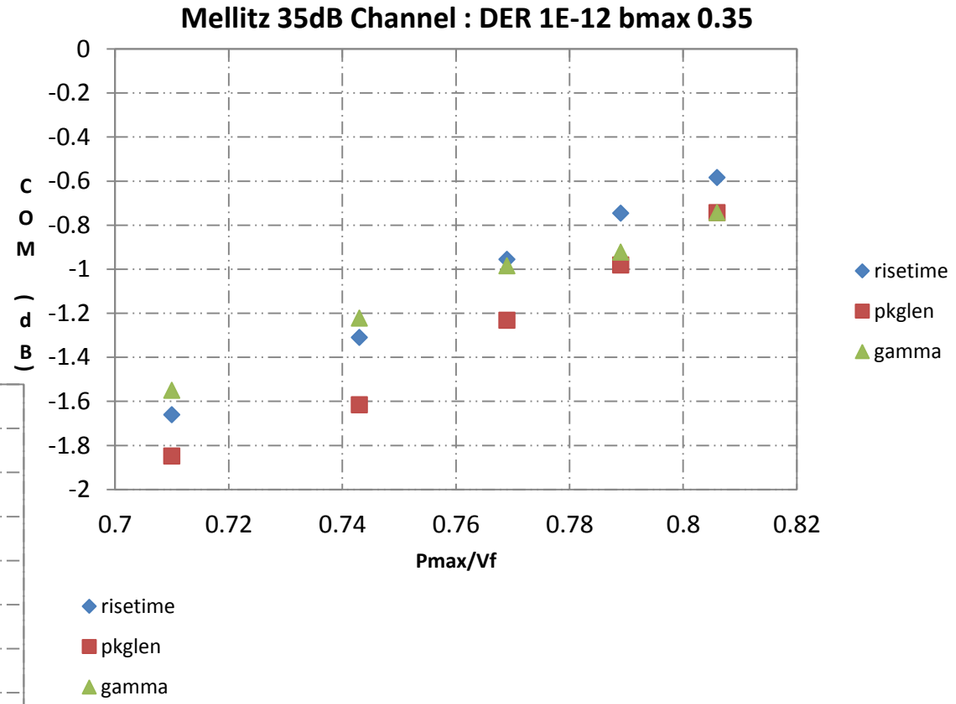
ADS PRBS9 (by die rise time)				COM Pulse (by package length)				COM Pulse (by Gamma)			
Package Length = 30mm Default COM Gamma				Default COM Source Default COM Gamma				Default COM Source Package Length = 30mm			
Rise Time [20% to 80%] (pS)	**Pmax (V)**	**Vf (V)**	**Pmax /Vf**	**TX Package Length (mm)**	**Pmax (V)**	**Vf (V)**	**Pmax /Vf**	**TX Package Gamma [0 a1 a2]**	**Pmax (V)**	**Vf (V)**	**Pmax /Vf**
1	0.292	0.363	0.806	30	0.294	0.365	0.804	[0 1.734e-3 1.455e-4]	0.294	0.365	0.804
8	0.286	0.363	0.789	38.3	0.282	0.358	0.787	[0 2.04612e-3 1.7169e-4]	0.286	0.363	0.787
12	0.279	0.363	0.769	44	0.274	0.356	0.768	[0 2.41e-3 2.022e-4]	0.277	0.361	0.767
16	0.269	0.363	0.743	53	0.261	0.354	0.739	[0 2.93046e-3 2.45895e-4]	0.264	0.358	0.739
20	0.257	0.363	0.710	62	0.249	0.350	0.711	[0 3.50e-3 2.94e-4]	0.251	0.354	0.710

- ADS PRBS9 (by die rise time): ADS simulated PRBS9 pattern at TP0a by varying die rise time
- COM Pulse (by package length): COM simulated pulse at TP0a by varying package length
- COM Pulse (by Gamma): COM simulated pulse at TP0a by varying Gamma

COM Plots on Mellitz 35dB Channel (mellitz_3bj_01_0713.pdf)

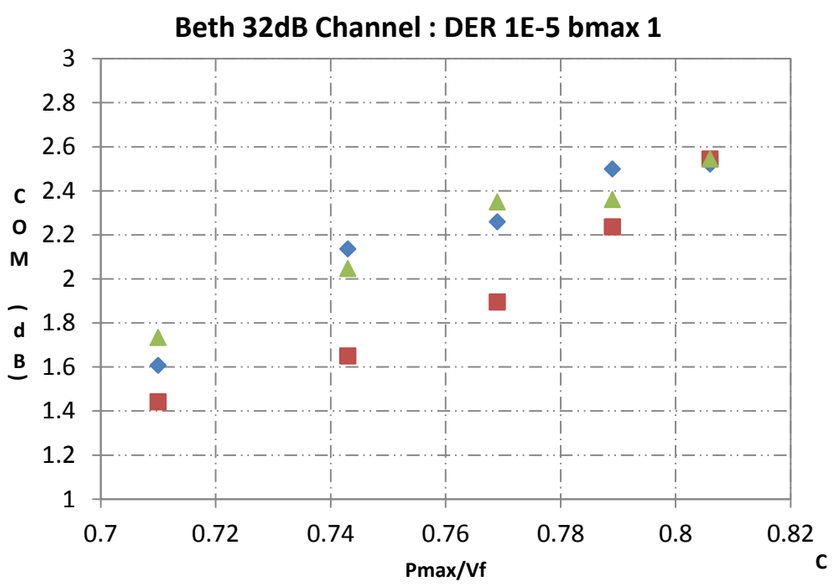


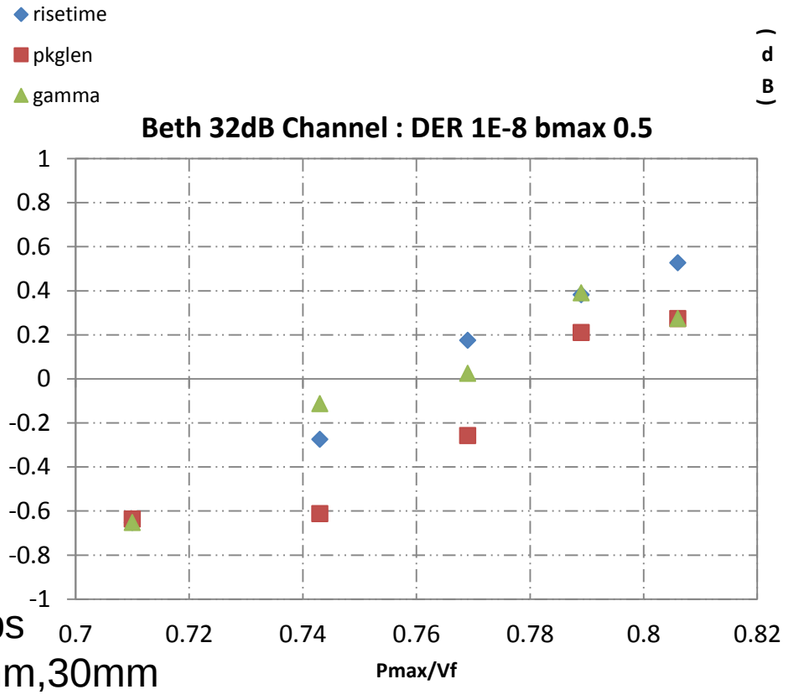


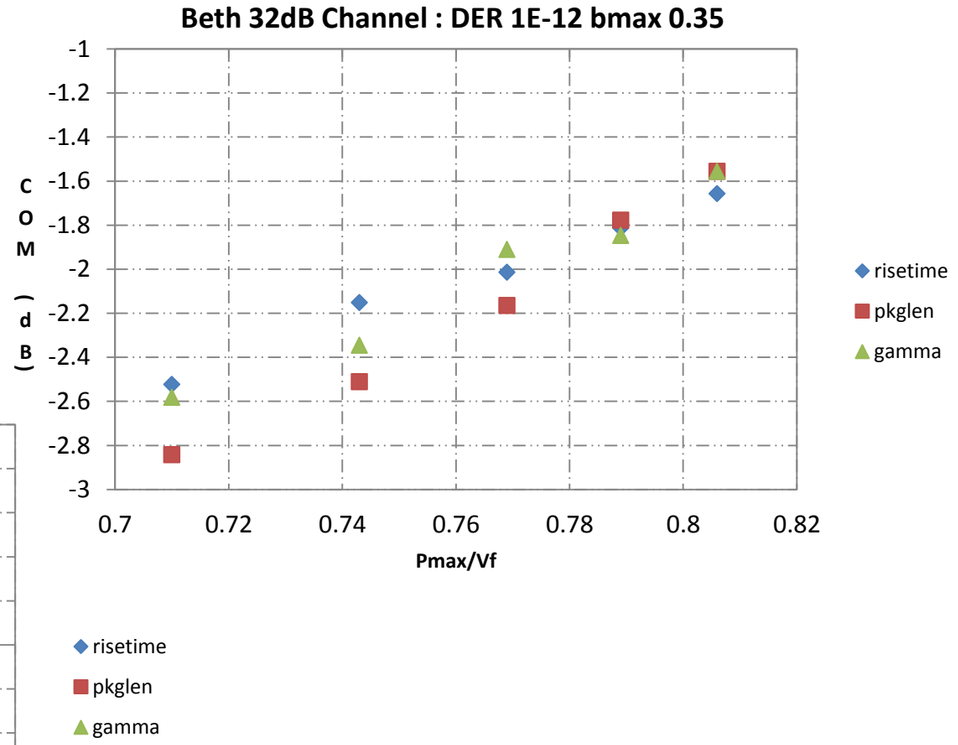


From left to right
risetime: 20ps, 16ps, 12ps, 8ps, 1ps
pkglen: 62mm,53mm,44mm,38.3mm,30mm
gamma: [0 3.50e-3 2.94e-4] [0 2.93046e-3 2.45895e-4] [0 2.41e-3 2.022e-4] [0 2.04612e-3 1.7169e-4] [0 1.734e-3 1.455e-4]

COM Plots on Beth 32dB Channel (kochuparambil_3bj_01_0913.pdf)

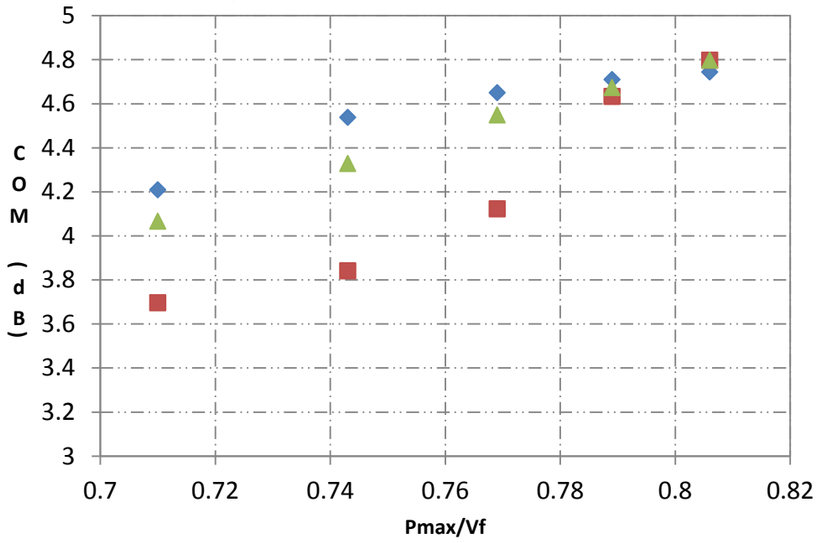


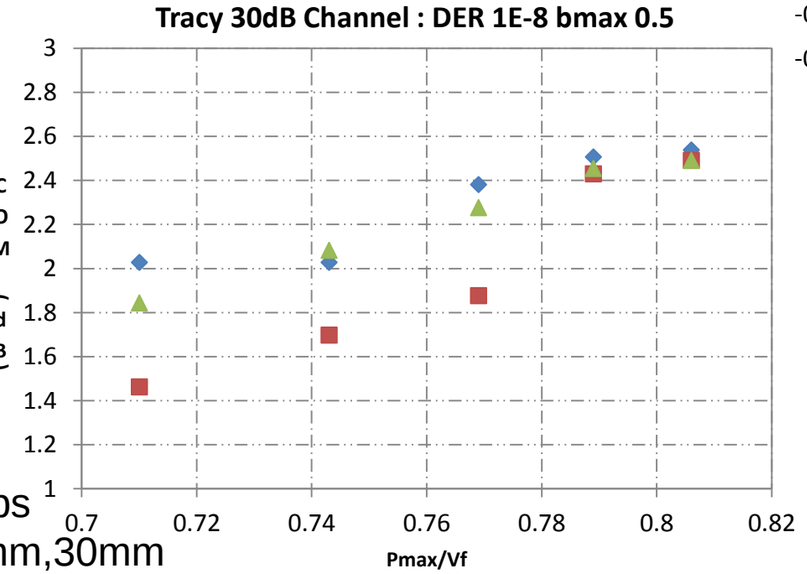


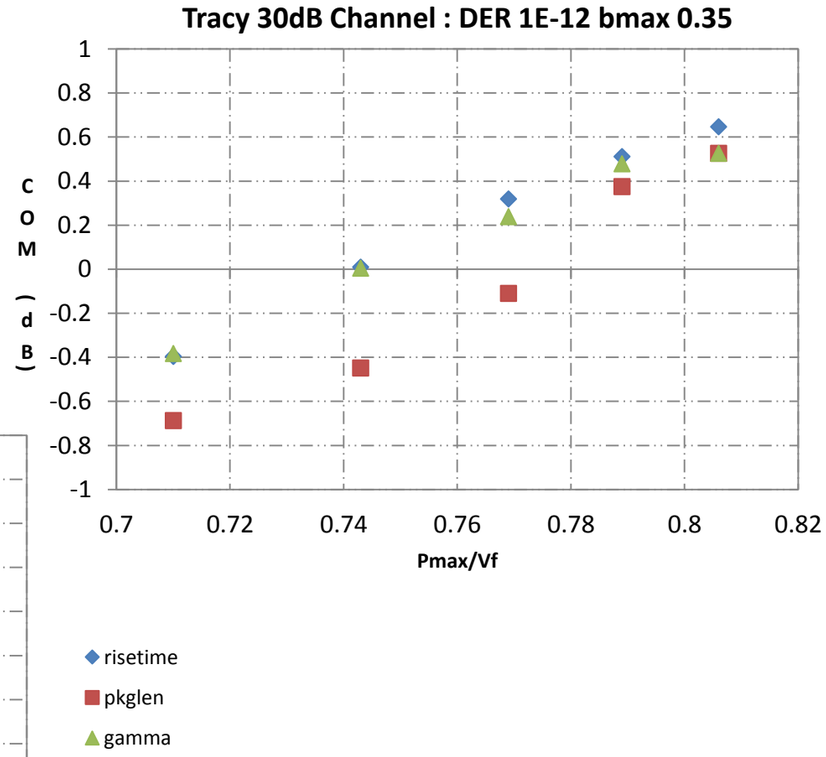


From left to right
risetime: 20ps, 16ps, 12ps, 8ps, 1ps
pkglen: 62mm,53mm,44mm,38.3mm,30mm
gamma: [0 3.50e-3 2.94e-4] [0 2.93046e-3 2.45895e-4] [0 2.41e-3 2.022e-4] [0 2.04612e-3 1.7169e-4] [0 1.734e-3 1.455e-4]

COM Plots on Tracy 30dB Channel (tracy_3bj_01_0713.pdf)

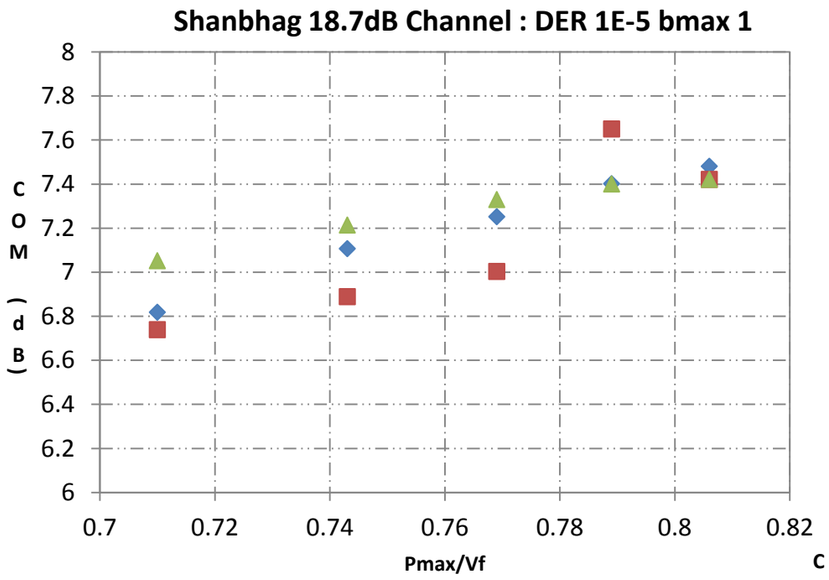


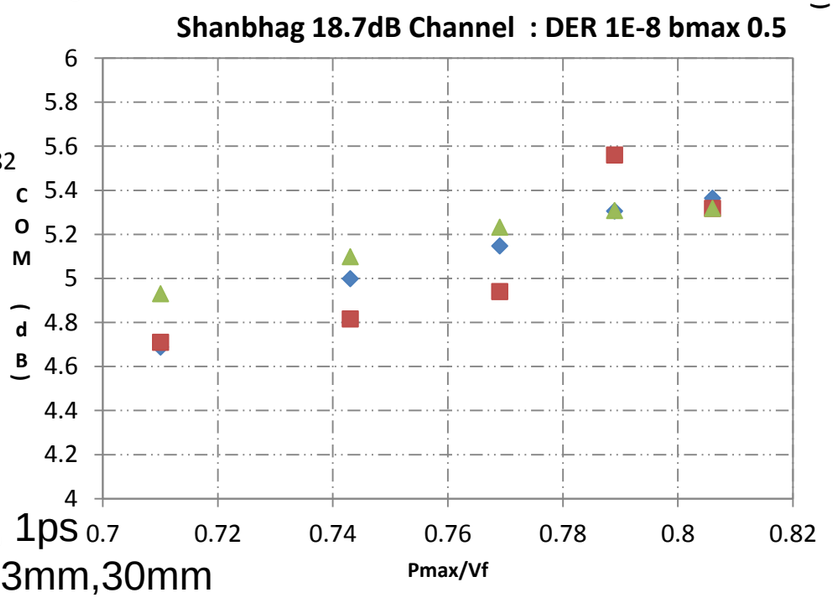


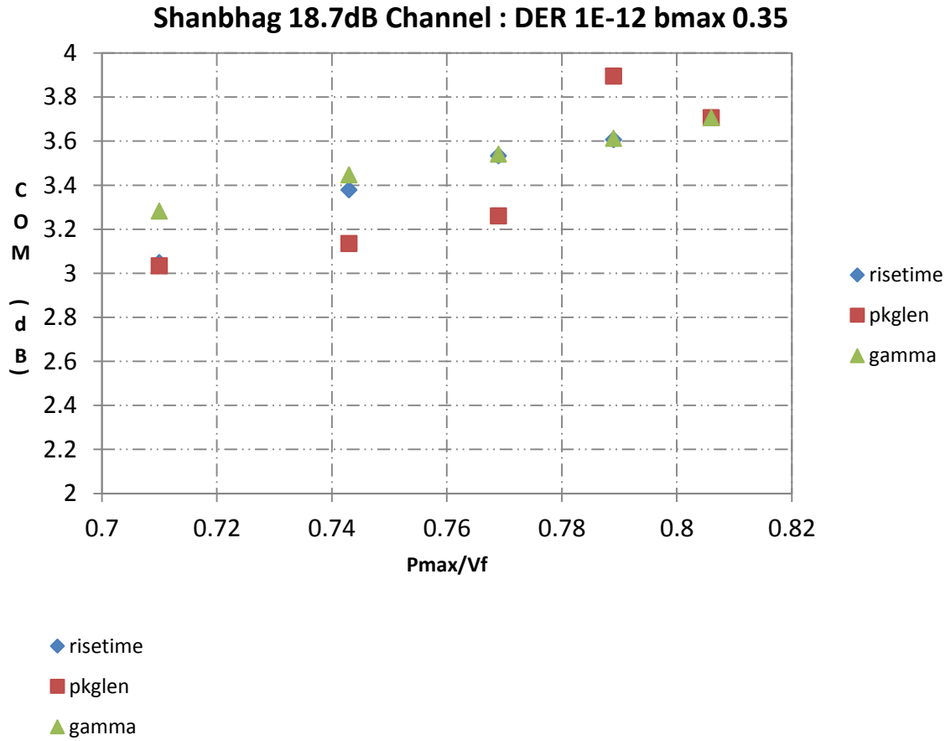


From left to right
risetime: 20ps, 16ps, 12ps, 8ps, 1ps
pkglen: 62mm,53mm,44mm,38.3mm,30mm
gamma: [0 3.50e-3 2.94e-4] [0 2.93046e-3 2.45895e-4] [0 2.41e-3 2.022e-4] [0 2.04612e-3 1.7169e-4] [0 1.734e-3 1.455e-4]

COM Plots on Shanbhag 18.7dB Channel (shanbhag_03_0411.pdf)







From left to right
risetime: 20ps, 16ps, 12ps, 8ps, 1ps
pkglen: 62mm,53mm,44mm,38.3mm,30mm
gamma: [0 3.50e-3 2.94e-4] [0 2.93046e-3 2.45895e-4] [0 2.41e-3 2.022e-4] [0 2.04612e-3 1.7169e-4] [0 1.734e-3 1.455e-4]

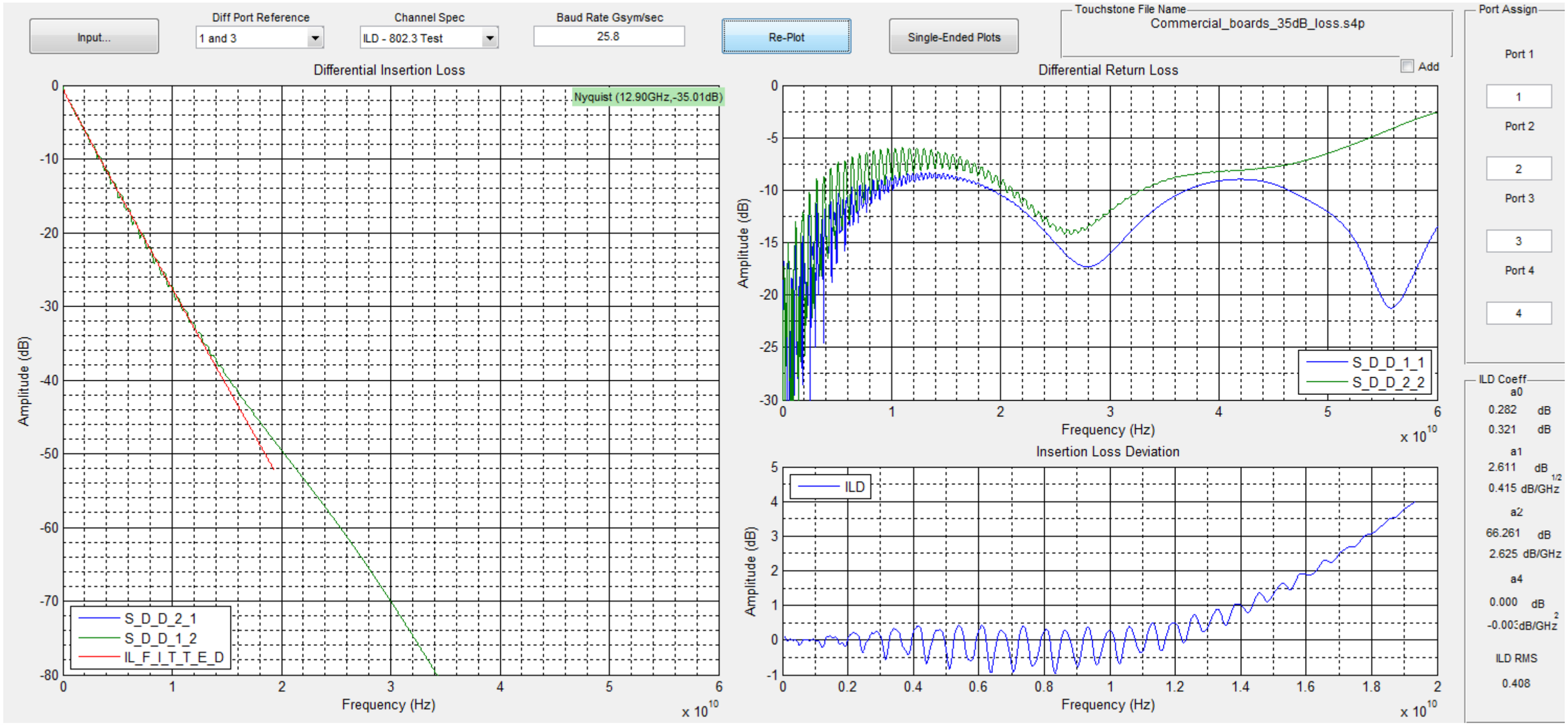
Conclusions

- The hole in the spec is not small being between 0.6 dB and 1.4dB in COM
- Increasing the Tx package length generally results in the worst degradation in COM and although it doesn't require any COM code change is probably not the best method as it creates reflections that are beyond the COM DFE length.
- Suggest a compromise of a Tx spec at TP0a for Pmax to Vf of 0.77 and modify the COM code to use 12ps risetime for the die for 802.3by.

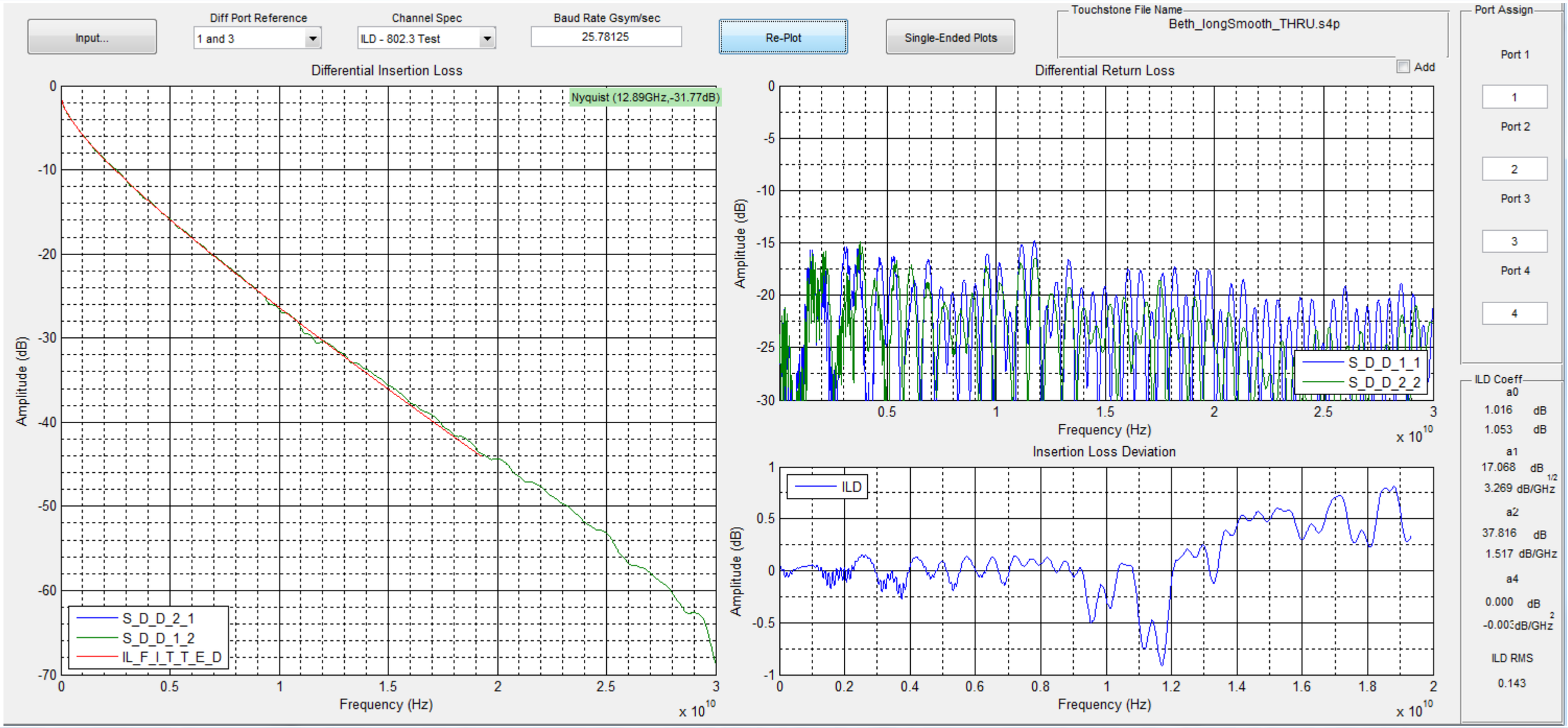
Copper Cable results
To be added

Backup - Backplane Channels used

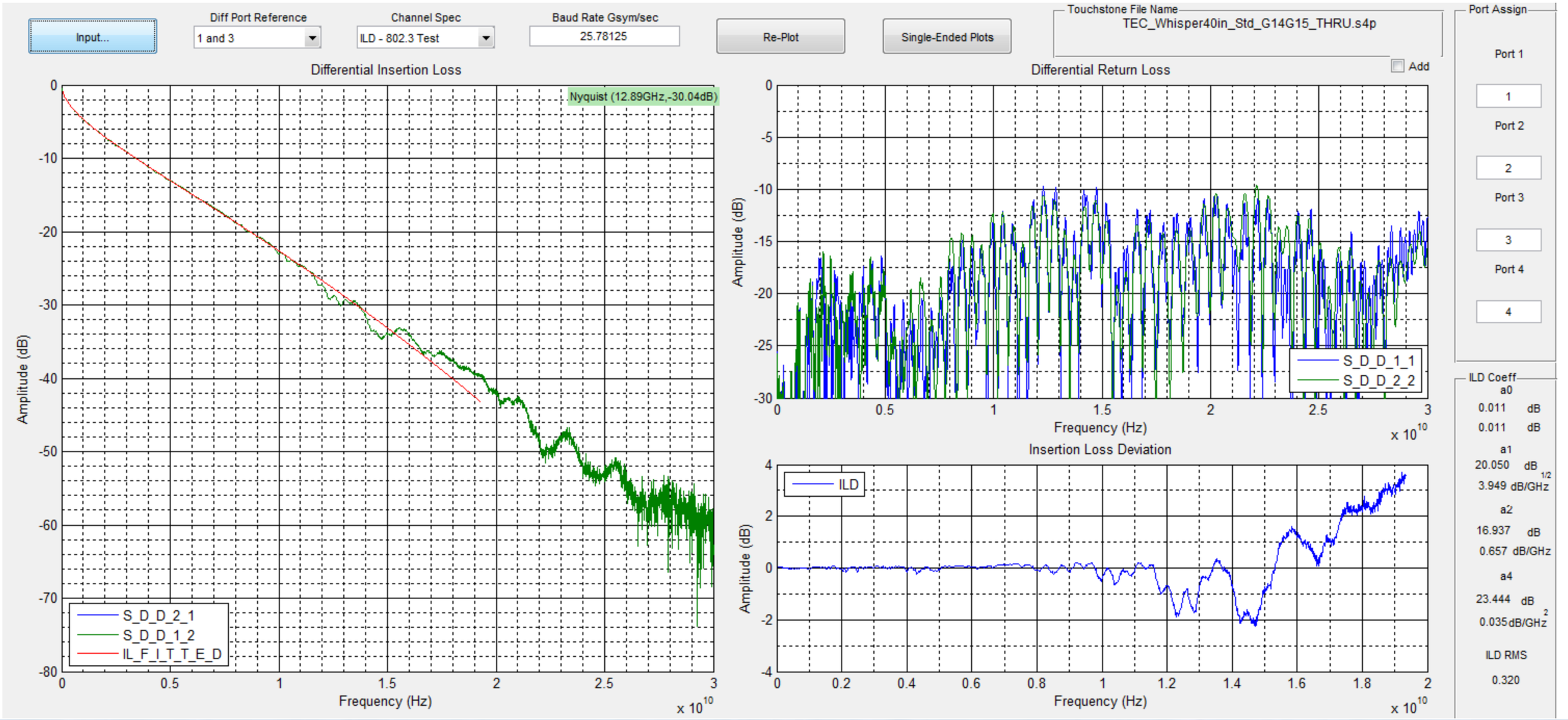
Mellitz 35dB FR4 Channel (mellitz_3bj_01_0713.pdf)



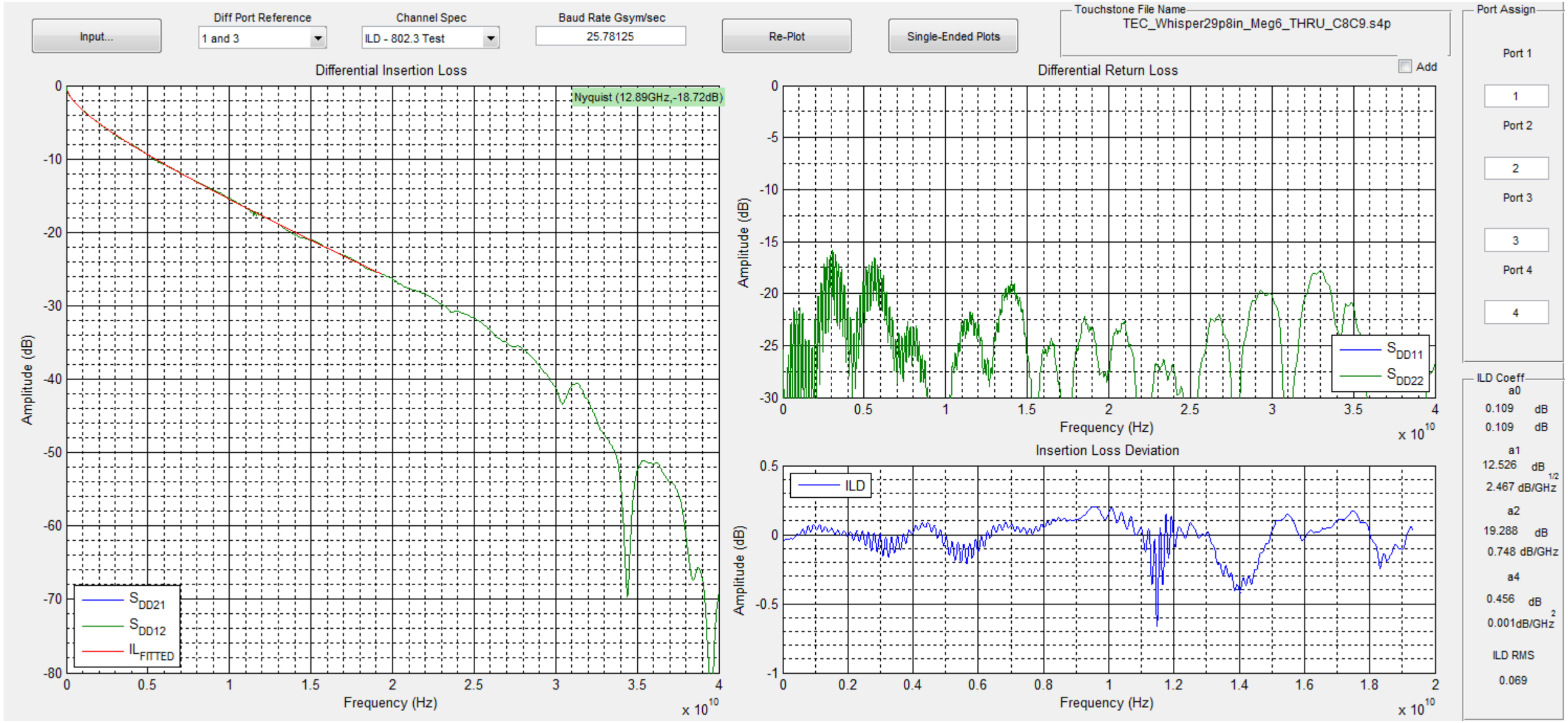
Beth 32dB Loss Channel (kochuparambil_3bj_01_0913.pdf)



Tracy 30dB Loss Channel (tracy_3bj_01_0713.pdf)

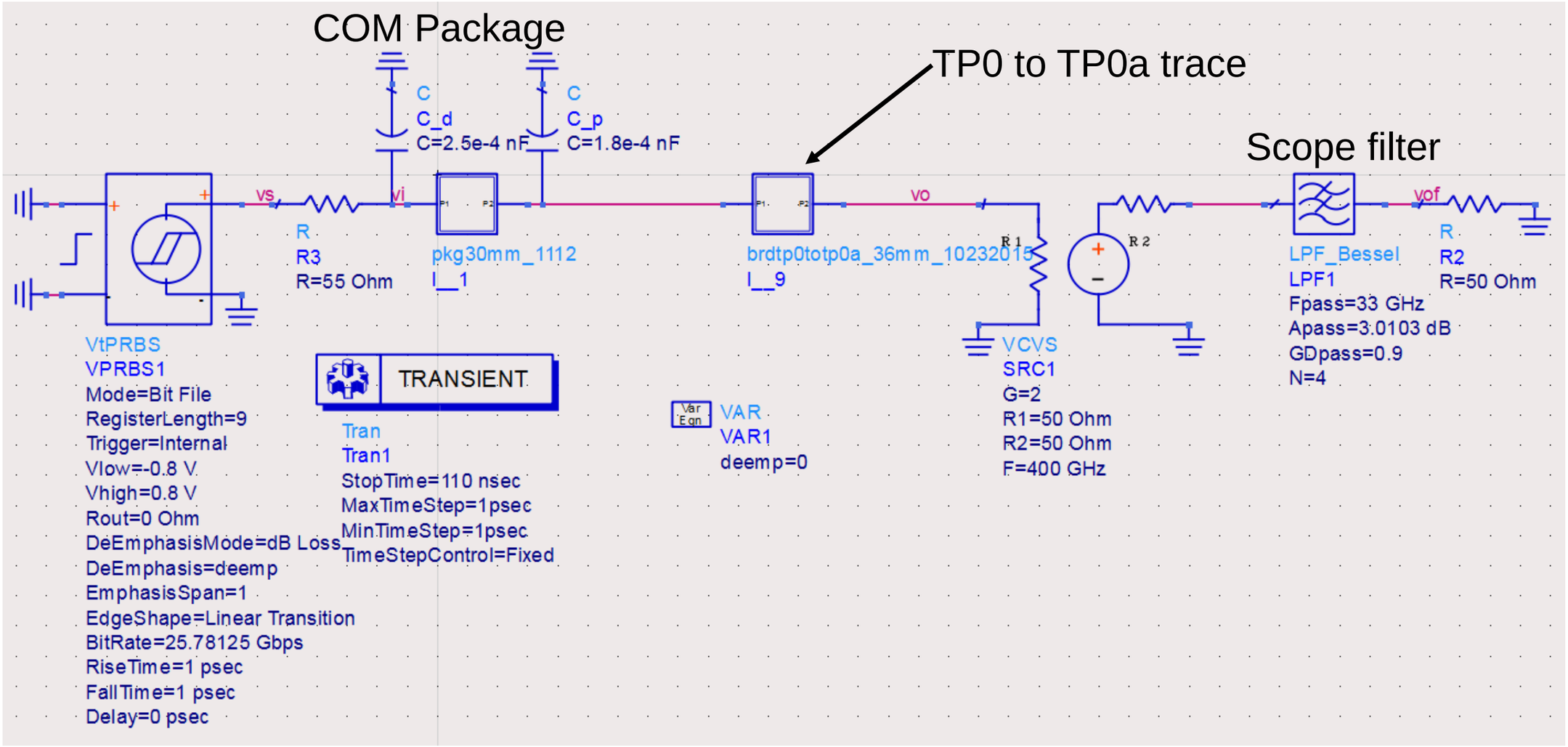


Shanbhag 18.7dB Loss Channel (shanbhag_03_0411.pdf)

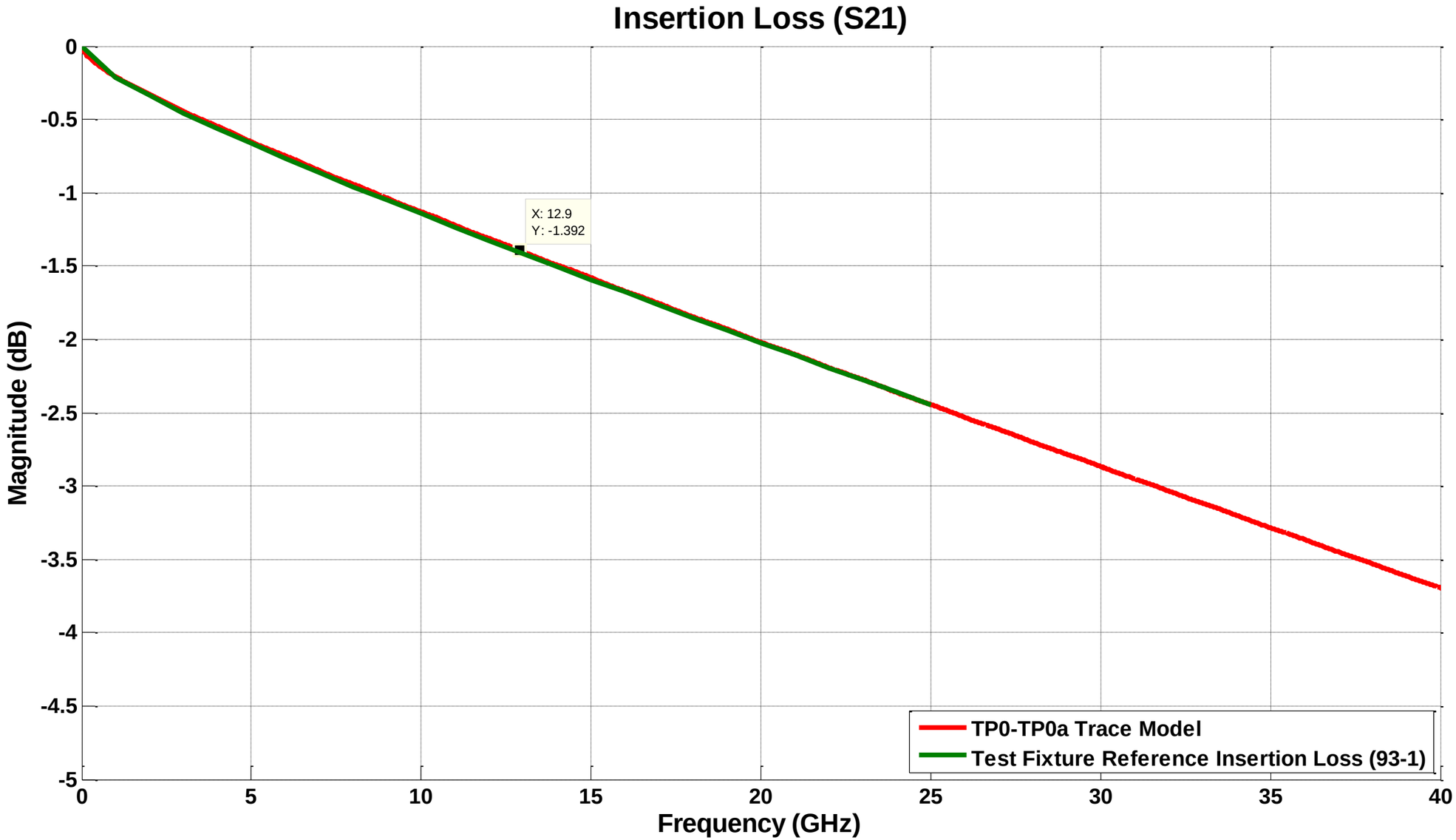


Backup (from Dudek_3by_01_0116)

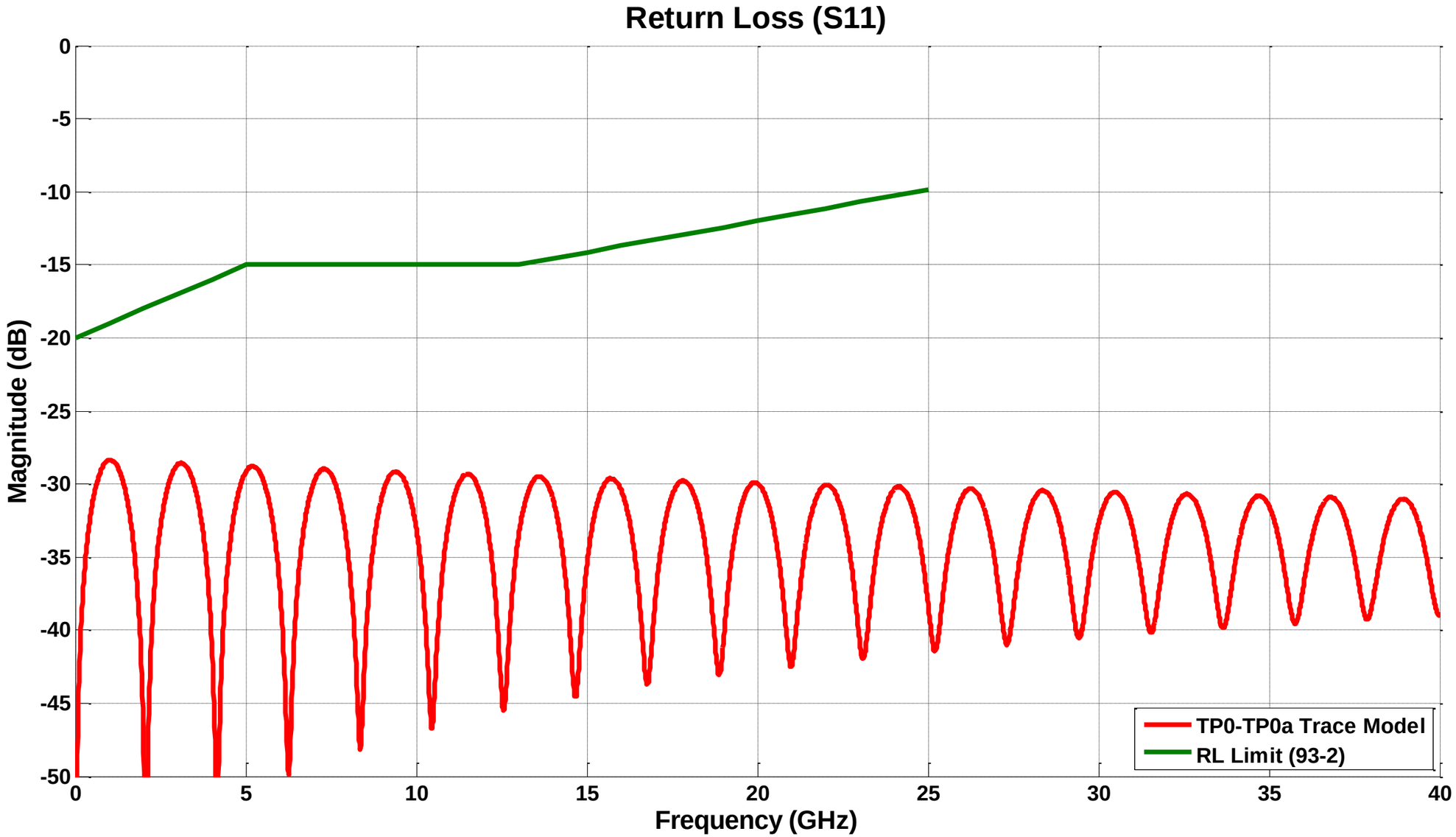
Channel Block Diagram for simulation at TP0a



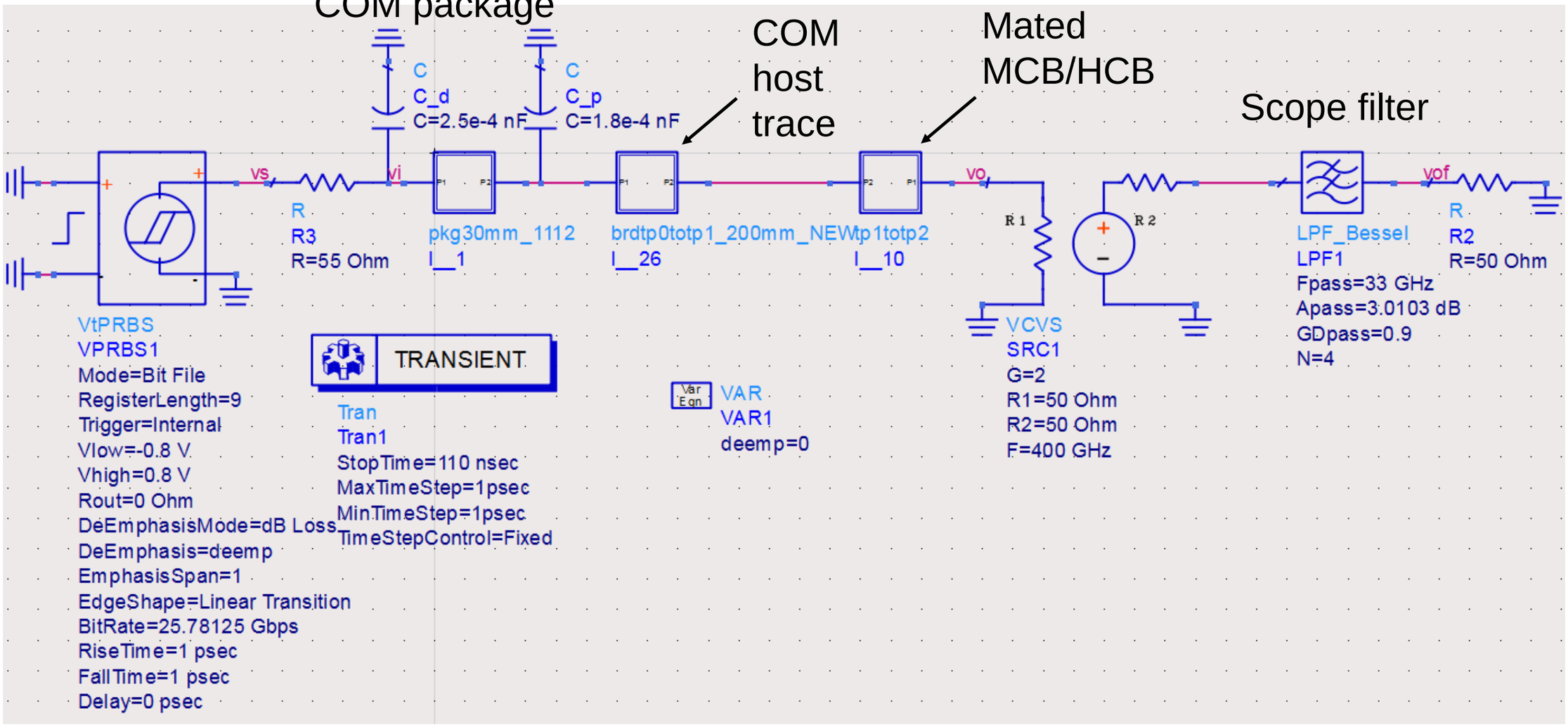
TP0 to TP0a Insertion loss



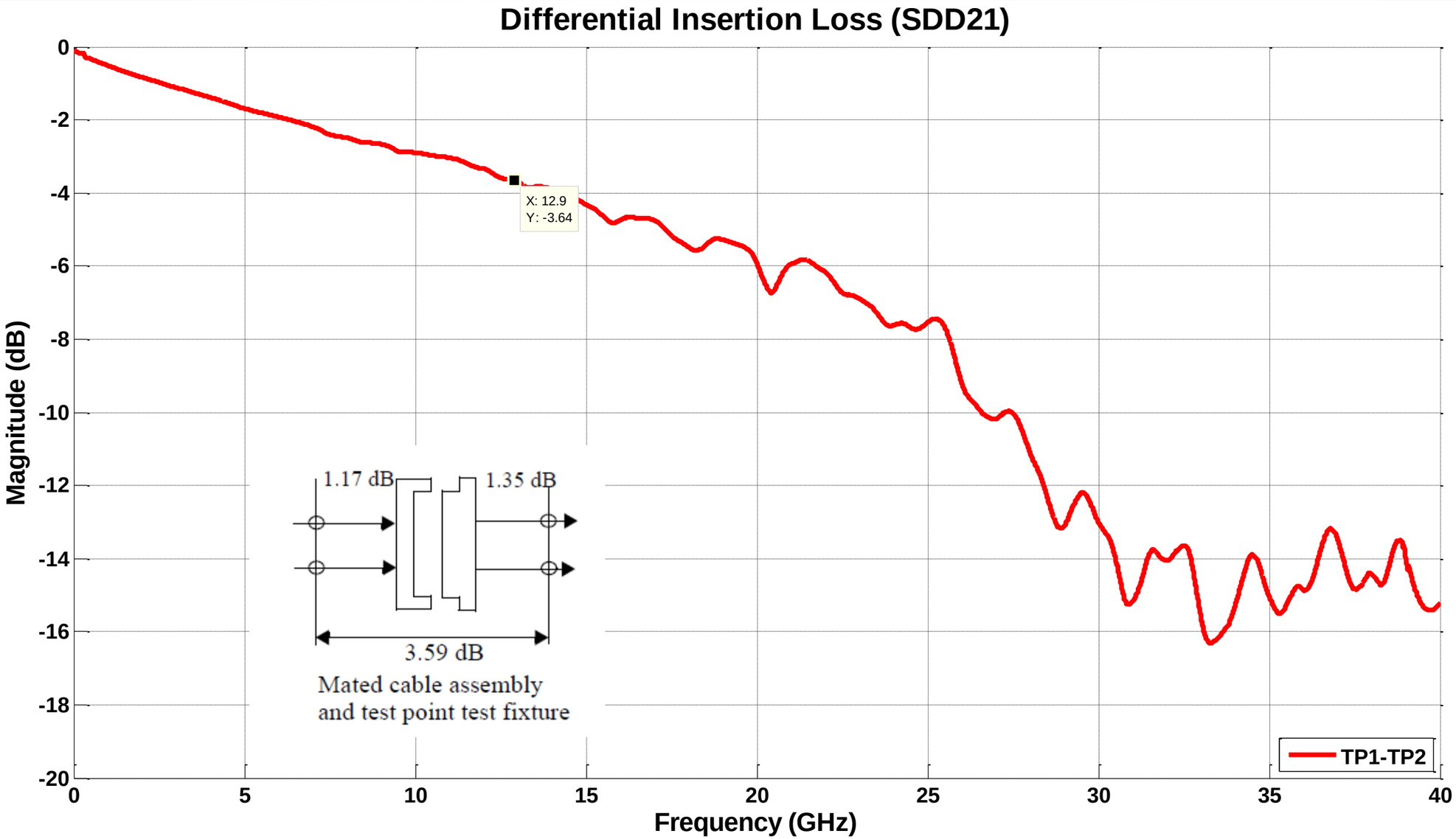
Tp0 to Tp0a Return loss



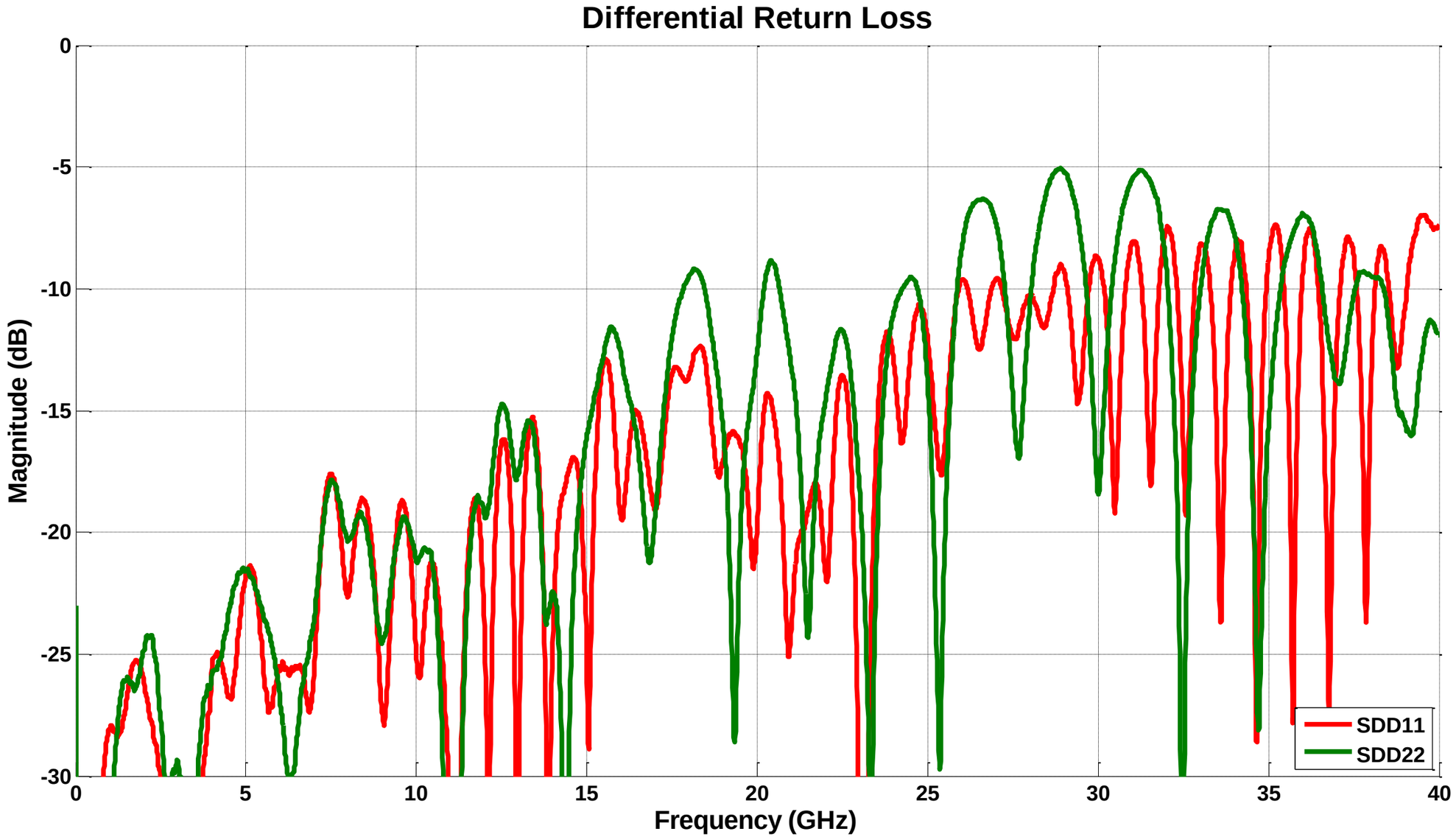
Channel Block Diagram for simulation at TP2



Tp1 to Tp2 Insertion loss (mated MCB/HCB)



Tp1 to Tp2 Return loss (mated MCB/HCB)



Results

	TP0a					TP2					
	Rise Time 1ps [20% to 80%]	Rise Time 8ps [20% to 80%]	Rise Time 12ps [20% to 80%]	Rise Time 20ps [20% to 80%]	SPEC (Table 93-4)	Rise Time 1ps [20% to 80%]	Rise Time 8ps [20% to 80%]	Rise Time 12ps [20% to 80%]	Rise Time 20ps [20% to 80%]	Units	SPEC (Table 92-6)
Host Board Length	Meet IL defined by Equation (93-1)					151				mm	
ADS PRBS Source Peak Voltage	0.8					0.8				V	
Sigmae	3.279	3.223	3.207	3.226		6.416	6.419	6.410	6.374	mV	
Pmax (Linear fit pulse peak)	0.292	0.286	0.279	0.257		0.169	0.167	0.164	0.155	V	
SNDR (@ Sigman = 0)	38.999	38.962	38.782	38.033	>=27dB	28.415	28.284	28.140	27.713	dB	>=26dB
Differential Peak to Peak Voltage	0.755	0.753	0.752	0.747	<=1.2V	0.676	0.675	0.674	0.672	V	<=1.2V
Vf (steady-state voltage)	0.363	0.363	0.363	0.363	0.4V=< Vf <=0.6V	0.339	0.339	0.339	0.339	V	0.34V=< Vf <=0.6V
Pmax/Vf	0.806	0.789	0.769	0.710	>=0.71	0.498	0.491	0.482	0.456	N/A	>=0.45
Sigman (for SNDR 27dB@TP0a for SNDR 26dB@TP2)	12.633	12.362	12.032	11.026		5.534	5.339	5.116	4.432	mV	
TXSNR (to achieve sigman above)	27.283	27.286	27.298	27.357		29.700	29.883	30.099	30.870	dB	

Conclusions and suggested change (from Dudek_3by_01_0116)

- The Pmax/Vf ratio allowed by both the backplane and copper cable specifications at TP0a and at TP2 is significantly lower than provided by the COM transmitter which uses the very fast risetime, creating a hole in the spec.
- These specifications allow a 20ps on die risetime even with the worst case long package. This is unnecessarily relaxed.
- Suggested change is to increase the Pmax/Vf ratio from 0.71 to 0.78 at TP0a and from 0.45 to 0.49 at TP2. (equivalent to approx. 10ps die risetime with the worst case package).

Note.

- Clause 92 of 802.3bj Tx specs at TP2 required a higher value of Tx_SNDR than was effectively used in COM which somewhat compensates for this.
- For the CA-25G-N cable we have reduced the amount of noise (increased Tx-SNR) used in COM to get closer to the Tx noise that the Tx specs allows, removing that compensation.

Backup - Backplane Numeric results

COM Table on Mellitz 35dB Channel (mellitz_3bj_01_0713.pdf)

Package Length = 30mm Default COM Gamma				Default COM Source Default COM Gamma				Default COM Source Package Length = 30mm			
Modified COM Rise Time [20% to 80%] (pS)	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35	TX Package Length (mm)	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35	TX Package Gamma [0 a1 a2]	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35
1	4.859	1.711	-0.584	30	4.828	1.704	-0.743	[0 1.734e-3 1.455e-4]	4.828	1.704	-0.743
8	4.790	1.523	-0.745	38.3	4.417	1.177	-0.981	[0 2.04612e-3 1.7169e-4]	4.787	1.468	-0.922
12	4.600	1.225	-0.955	44	4.315	1.054	-1.232	[0 2.41e-3 2.022e-4]	4.635	1.36	-0.984
16	4.381	0.989	-1.31	53	4.082	0.727	-1.615	[0 2.93046e-3 2.45895e-4]	4.408	0.926	-1.222
20	4.152	0.56	-1.661	62	4.027	0.464	-1.848	[0 3.50e-3 2.94e-4]	4.124	0.682	-1.549

Thru : Commercial_boards_35dB_loss.s4p
No xtalk

COM Table on Beth 32dB Channel (kochuparambil_3bj_01_0913.pdf)

Package Length = 30mm Default COM Gamma				Default COM Source Default COM Gamma				Default COM Source Package Length = 30mm			
Modified COM Rise Time [20% to 80%] (pS)	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35	TX Package Length (mm)	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35	TX Package Gamma [0 a1 a2]	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35
1	2.522	0.528	-1.656	30	2.545	0.274	-1.555	[0 1.734e-3 1.455e-4]	2.545	0.274	-1.555
8	2.499	0.382	-1.812	38.3	2.236	0.211	-1.777	[0 2.04612e-3 1.7169e-4]	2.361	0.391	-1.847
12	2.259	0.175	-2.014	44	1.895	-0.257	-2.165	[0 2.41e-3 2.022e-4]	2.350	0.026	-1.910
16	2.136	-0.274	-2.151	53	1.650	-0.612	-2.510	[0 2.93046e-3 2.45895e-4]	2.047	-0.112	-2.345
20	1.608	-0.652	-2.523	62	1.442	-0.636	-2.842	[0 3.50e-3 2.94e-4]	1.734	-0.652	-2.581

Thru: Beth_longSmooth_THRU.s4p
FEXT: Beth_longSmooth_FEXT.s4p
NEXT: Beth_longSmooth_NEXT.s4p

COM Table on Tracy 30dB Channel (tracy_3bj_01_0713.pdf)

Package Length = 30mm Default COM Gamma				Default COM Source Default COM Gamma				Default COM Source Package Length = 30mm			
Modified COM Rise Time [20% to 80%] (pS)	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35	TX Package Length (mm)	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35	TX Package Gamma [0 a1 a2]	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35
1	4.745	2.538	0.647	30	4.798	2.491	0.526	[0 1.734e-3 1.455e-4]	4.798	2.491	0.526
8	4.710	2.506	0.512	38.3	4.634	2.43	0.375	[0 2.04612e-3 1.7169e-4]	4.674	2.454	0.479
12	4.65	2.381	0.319	44	4.123	1.876	-0.11	[0 2.41e-3 2.022e-4]	4.55	2.276	0.239
16	4.539	2.027	0.01	53	3.842	1.697	-0.449	[0 2.93046e-3 2.45895e-4]	4.329	2.082	0.005
20	4.209	2.028	-0.396	62	3.697	1.462	-0.687	[0 3.50e-3 2.94e-4]	4.067	1.844	-0.383

Thru: TEC_Whisper40in_Std_G14G15_THRU.s4p

FEXT

- TEC_Whisper40in_Std_G14G15_F11F12_FEXT.s4p
- TEC_Whisper40in_Std_G14G15_F17F18_FEXT.s4p
- TEC_Whisper40in_Std_G14G15_H11H12_FEXT.s4p
- TEC_Whisper40in_Std_G14G15_H17H18_FEXT.s4p

NEXT

- TEC_Whisper40in_Std_G14G15_F14F15_NEXT.s4p
- TEC_Whisper40in_Std_G14G15_G11G12_NEXT.s4p
- TEC_Whisper40in_Std_G14G15_G17G18_NEXT.s4p
- TEC_Whisper40in_Std_G14G15_H14H15_NEXT.s4p

COM Table on Shanbhag 18.7dB Channel (shanbhag_03_0411.pdf)

Package Length = 30mm Default COM Gamma				Default COM Source Default COM Gamma				Default COM Source Package Length = 30mm			
Modified COM Rise Time [20% to 80%] (pS)	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35	TX Package Length (mm)	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35	TX Package Gamma [0 a1 a2]	DER=1E-5 bmax=1	DER=1E-8 bmax=0.5	DER=1E-12 bmax=0.35
1	7.481	5.364	3.699	30	7.422	5.318	3.707	[0 1.734e-3 1.455e-4]	7.422	5.318	3.707
8	7.402	5.306	3.607	38.3	7.651	5.560	3.895	[0 2.04612e-3 1.7169e-4]	7.401	5.308	3.613
12	7.252	5.147	3.534	44	7.004	4.94	3.26	[0 2.41e-3 2.022e-4]	7.330	5.233	3.541
16	7.107	4.999	3.379	53	6.889	4.816	3.135	[0 2.93046e-3 2.45895e-4]	7.214	5.099	3.447
20	6.818	4.688	3.048	62	6.739	4.71	3.034	[0 3.50e-3 2.94e-4]	7.052	4.931	3.282

Thru: TEC_Whisper29p8in_Meg6_THRU_C8C9.s4p

FEXT

- TEC_Whisper29p8in_Meg6_FEXT_B5B6_C8C9.s4p
- TEC_Whisper29p8in_Meg6_FEXT_B8B9_C8C9.s4p
- TEC_Whisper29p8in_Meg6_FEXT_B11B12_C8C9.s4p
- TEC_Whisper29p8in_Meg6_FEXT_C5C6_C8C9.s4p
- TEC_Whisper29p8in_Meg6_FEXT_C11C12_C8C9.s4p
- TEC_Whisper29p8in_Meg6_FEXT_D5D6_C8C9.s4p
- TEC_Whisper29p8in_Meg6_FEXT_D8D9_C8C9.s4p
- TEC_Whisper29p8in_Meg6_FEXT_D11D12_C8C9.s4p

NEXT

- TEC_Whisper29p8in_Meg6_NEXT_B5B6_C8C9.s4p
- TEC_Whisper29p8in_Meg6_NEXT_B5B6_C8C9.s4p
- TEC_Whisper29p8in_Meg6_NEXT_B8B9_C8C9.s4p
- TEC_Whisper29p8in_Meg6_NEXT_B11B12_C8C9.s4p
- TEC_Whisper29p8in_Meg6_NEXT_C5C6_C8C9.s4p
- TEC_Whisper29p8in_Meg6_NEXT_C11C12_C8C9.s4p
- TEC_Whisper29p8in_Meg6_NEXT_D8D9_C8C9.s4p
- TEC_Whisper29p8in_Meg6_NEXT_D11D12_C8C9.s4p