



100G CR End-to-End Channel Analysis Update (II)

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100G CR End-to-End Channel Model - Updated

- At July Vienna meeting, lim_3ck_01_0719 analyzed worst case 2m cable model with end-to-end loss upto 29 dB
 - Data shows fail to pass 3dB COM
- This presentation revisits the 2m cable channel with the following changes:
 - ASIC RX FP NEXT further improvement
 - Max cable model loss reduced from 20.0 dB to 19.75 dB (TP1 – TP4)
 - Host PCB loss is reduced from 7.0 dB to 6.875 dB at both ends
 - New target end-to-end channel loss - 28.5 dB
- The mated cable models used in the analysis is simulation based, generated at worst case manufacturing condition
- Use latest COM scripts 2.70, see backup slides for COM configs

End-to-End Channel Model Overview

- Host PCB stack-up is 30 layers, 150mil thick, with Meg7 material
- Host PCB via stub length is modelled as 7mil
- Diff pair trace width/spacing is 4.5mil/8.5mil
- ASIC package BGA footprint is extracted in HFSS using the same PCB stack-up
- 16 pairs (8 Tx, 8 Rx) QSFP-DD Connector and host PCB footprint and wire termination are solved in HFSS

QSFP-DD Channel Buildup

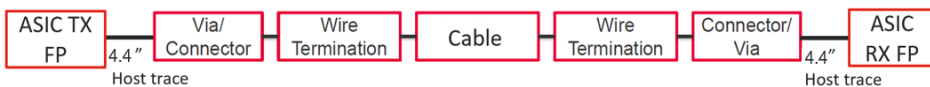


- Channels 3a (new pair) / 3b (legacy pair) – worst case condition: 28.5dB IL

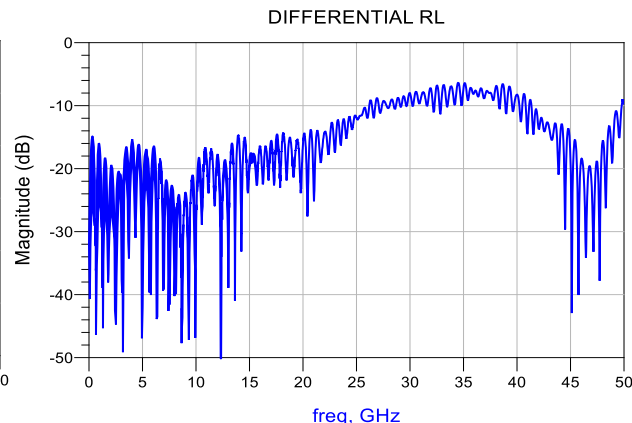
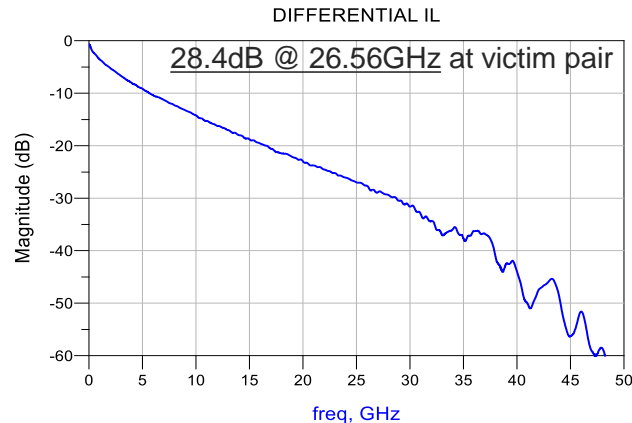
ASIC BGA footprint (mid length via) TX + host PCB trace 4.4" + [QSFP-DD footprint & connector (new/legacy pair) + wire termination + 2m 26AWG cable (mfg variation) + wire termination + QSFP-DD footprint & connector (new/legacy pair)] + host PCB trace 4.4" + improved ASIC BGA footprint (long via) RX (Thru and FEN channel description)

Improved ASIC BGA footprint (long via) RX + host PCB trace 4.4" + [QSFP-DD footprint & connector (new/legacy pair) + wire termination + 2m 26AWG cable (mfg variation) + wire termination + QSFP-DD footprint & connector (new/legacy pair)] + host PCB trace 4.4" + ASIC BGA footprint (mid length via) TX (NEN channel description)

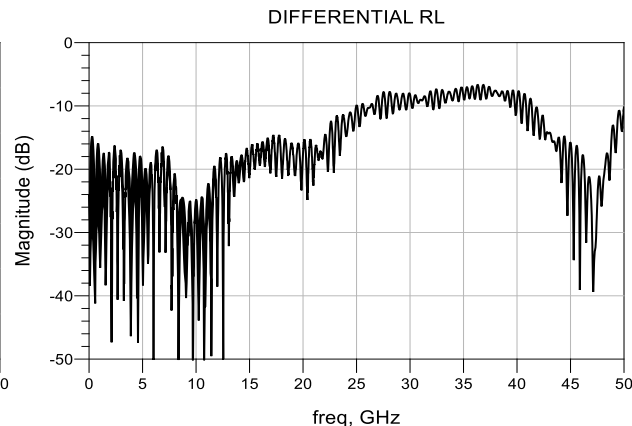
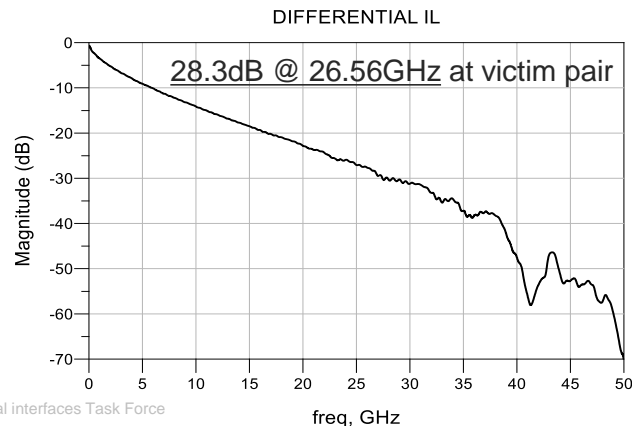
QSFP-DD Channel 3a/3b: Diff. Insertion Loss, Return Loss



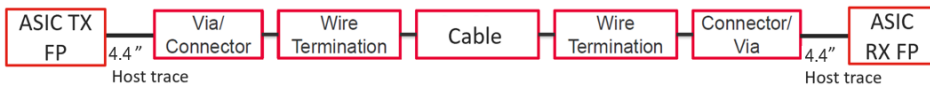
QSFP-DD
Channel 3a
(new pair)



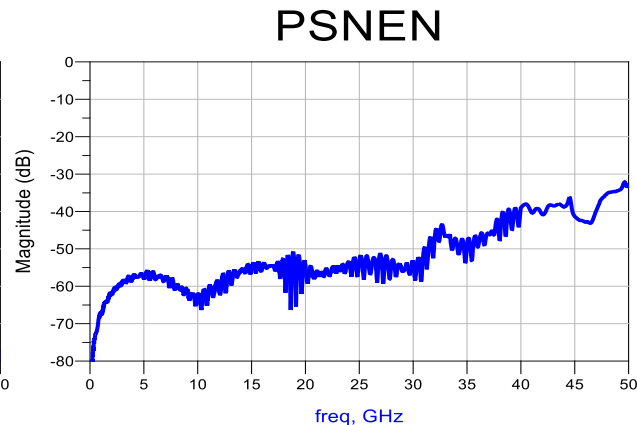
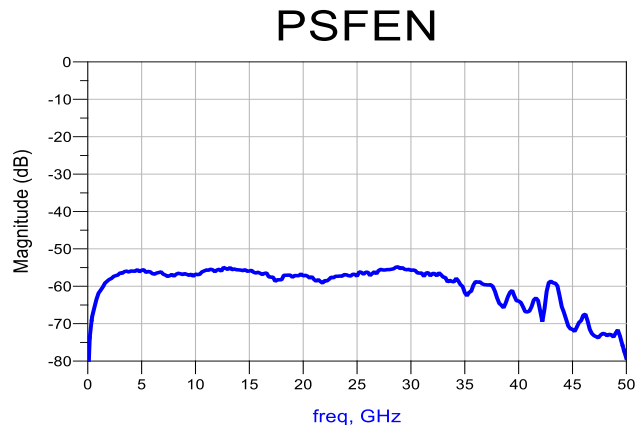
QSFP-DD
Channel 3b
(legacy pair)



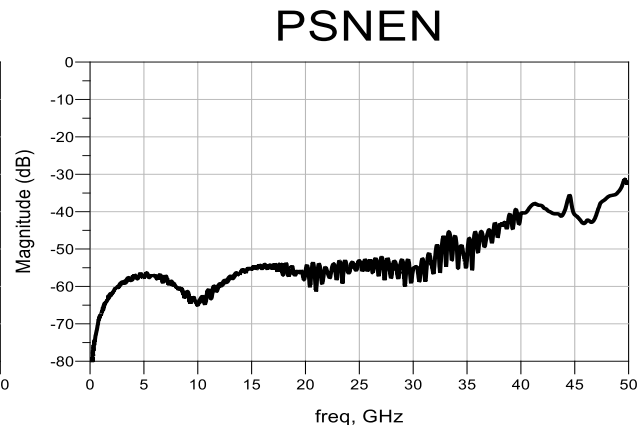
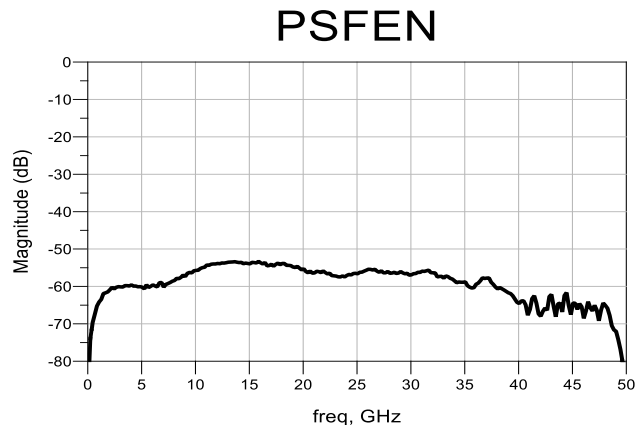
QSFP-DD Channel 3a/3b: Far-end and Near-end Crosstalk



QSFP-DD
Channel 3a
(new pair)



QSFP-DD
Channel 3b
(legacy pair)



106G PAM-4 COM Results

| DUT | COM case 1 (dB) | COM case 2 (dB) | ERL11 (dB) | ERL2 2 (dB) | FOM _{ILD} (dB _{Rms}) | ICN (mV) | IL@26G b2b/d2d (dB) |
|--|-----------------|-----------------|------------|-------------|---|----------|---------------------|
| Channel 3a (QSFPDD, new pair, worst case) | 3.80 | 2.90 | 16.82 | 17.57 | 0.48 | 1.16 | 28.4/40.9 |
| Channel 3b (QSFPDD, legacy pair, worst case) | 3.84 | 3.16 | 18.33 | 18.91 | 0.58 | 1.21 | 28.3/41.1 |

COM script version 2.70

- **Die termination C: Cd 120fF / Ls 120pH/ Cb 30fF**
- **24 fixed DFE taps**

Case 1: z_p (TX) = 12 mm; z_p (RX) = 12 mm

Case 2: z_p (TX) = 31 mm; z_p (RX) = 29 mm

Summary

- The updated 2m CR channels with cable assemblies manufacturing variation have IL close to 28.5 dB
 - Data shows ~0.8 – 1.0 dB COM improvement compared to previously generated 29 dB channels
 - QSFP-DD legacy pair can now pass 3 dB COM target, the DD new pair is missing 0.1dB (under development by Molex)
 - ICN has been improved from ~1.5mV to ~1.2mV, mainly coming from ASIC RX footprint NEXT reduction
- 28.5dB loss budget (informative) looks promising for 2m Cu cable assembly baseline consideration

Backup Slides

Config_com_ieee8023_93a_3ck_KR_mellitz_06_12_2019 COM 2.70

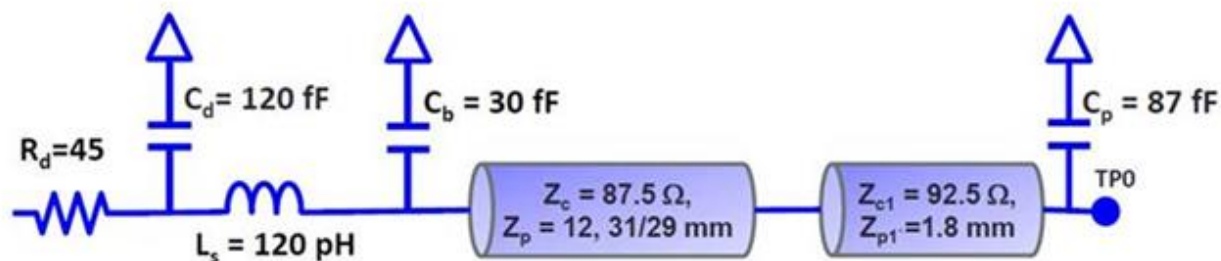
Die termination C – Fixed 24 DFE taps

| Table 93A-1 parameters | | | |
|------------------------|-------------------|-------|---------------------|
| Parameter | Setting | Units | Information |
| f_b | 53.125 | GBd | |
| f_min | 0.05 | GHz | |
| Delta_f | 0.01 | GHz | |
| C_d | [1.2e-4 1.2e-4] | nF | [TX RX] |
| L_s | [0.12, 0.12] | nH | [TX RX] |
| C_b | [0.3e-4 0.3e-4] | nF | [TX RX] |
| z_p select | [1 2] | | [test cases to run] |
| z_p (TX) | [12 31; 1.8 1.8] | mm | [test cases] |
| z_p (NEXT) | [12 29; 1.8 1.8] | mm | [test cases] |
| z_p (FEXT) | [12 31; 1.8 1.8] | mm | [test cases] |
| z_p (RX) | [12 29; 1.8 1.8] | mm | [test cases] |
| C_p | [0.87e-4 0.87e-4] | nF | [TX RX] |
| R_0 | 50 | Ohm | |
| R_d | [45 45] | Ohm | [TX RX] |
| A_v | 0.39 | V | vp/vf=.694 |
| A_fe | 0.39 | V | vp/vf=.694 |
| A_ne | 0.578 | V | |
| L | 4 | | |
| M | 32 | | |
| filter and Eq | | | |
| f_r | 0.75 | *fb | |
| c(0) | 0.5 | | min |
| c(-1) | [-0.3:0.02:0] | | [min:step:max] |
| c(-2) | [0:0.02:0.12] | | [min:step:max] |
| c(-3) | [-0.06:0.02:0] | | [min:step:max] |
| c(1) | [-0.2:0.05:0] | | [min:step:max] |
| N_b | 24 | UI | |
| b_max(1) | 0.85 | | |
| b_max(2..N_b) | 0.3 | | |
| g_DC | [-20:1:0] | dB | [min:step:max] |
| f_z | 21.25 | GHz | |
| f_p1 | 21.25 | GHz | |
| f_p2 | 53.125 | GHz | |
| g_DC_HP | [-6:1:0] | | [min:step:max] |

| I/O control | | |
|---------------------|-----------------------------|---------|
| DIAGNOSTICS | 1 | logical |
| DISPLAY_WINDOW | 1 | logical |
| CSV_REPORT | 1 | logical |
| RESULT_DIR | .\results\100GEL_KR_{date}\ | |
| SAVE_FIGURES | 1 | logical |
| Port Order | [1 3 2 4] | |
| RUNTAG | KR_eval_ | |
| COM_CONTRIBUTION | 0 | logical |
| Operational | | |
| COM Pass threshold | 3 | dB |
| ERL Pass threshold | 10 | dB |
| DER_0 | 1.00E-04 | |
| T_r | 6.16E-03 | ns |
| FORCE_TR | 1 | logical |
| Include PCB | 0 | logical |
| TDR and ERL options | | |
| TDR | 1 | logical |
| ERL | 1 | logical |
| ERL_ONLY | 0 | logical |
| TR_TDR | 0.01 | ns |
| N | 3000 | |
| beta_x | 2.53E+09 | |
| rho_x | 0.25 | |
| fixture delay time | 0 | s |
| TDR_W_TXPKG | 0 | |
| N_bx | 24 | UI |
| Receiver testing | | |
| RX_CALIBRATION | 0 | logical |
| Sigma BBN step | 5.00E-03 | V |
| Noise, jitter | | |
| sigma_RJ | 0.01 | UI |
| A_DD | 0.02 | UI |
| eta_0 | 8.20E-09 | V^2/GHz |
| SNR_TX | 33 | dB |
| R_LM | 0.95 | |

| Table 93A-3 parameters | | |
|--|--------------------------|---|
| Parameter | Setting | Units |
| package_tl_gamma0_a1_a2 | [0 0.0009909 0.0002772] | |
| package_tl_tau | 6.141E-03 | ns/mm |
| package_Z_c | [87.5 87.5 ; 92.5 92.5] | Ohm |
| Table 92-12 parameters 5.2dB at 26.56GHz | | |
| Parameter | Setting | |
| board_tl_gamma0_a1_a2 | [0 0.000599 0.0001022] | 1.286 dB/in or 0.0506 dB/mm at 100 ohms |
| board_tl_tau | 6.200E-03 | ns/mm |
| board_Z_c | 90 | Ohm |
| z_bp (TX) | 102.7 | mm |
| z_bp (NEXT) | 102.7 | mm |
| z_bp (FEXT) | 102.7 | mm |
| z_bp (RX) | 102.7 | mm |
| Floating Tap Control | | |
| N_bg | 0 | 0 12 or 3 groups |
| N_bf | 0 | taps per group |
| N_f | 40 | UI span for floating taps |
| bmaxg | 0.1 | max DFE value for floating taps |
| yellow indicates WIP | | |

Package Proposal with LC Termination Compensation (single sided model)



| Parameter | Setting | Units | Information |
|------------|--------------------|-------|---------------------|
| C_d | [1.2e-4 1.2e-4] | nF | [TX RX] |
| L_s | [0.12, 0.12] | nH | [TX RX] |
| C_b | [0.3e-4 0.3e-4] | nF | [TX RX] |
| z_p select | [1 2] | | [test cases to run] |
| z_p (TX) | [12 31; 1.8 1.8] | mm | [test cases] |
| z_p (NEXT) | [12 29; 1.8 1.8] | mm | [test cases] |
| z_p (FEXT) | [12 31; 1.8 1.8] | mm | [test cases] |
| z_p (RX) | [12 2990; 1.8 1.8] | mm | [test cases] |
| C_p | [0.87e-4 0.87e-4] | nF | [TX RX] |
| R_0 | 50 | Ohm | |
| R_d | [45 45] | Ohm | [TX RX] |
| A_v | 0.39 | V | vp/vf=.694 |
| A_fe | 0.39 | V | vp/vf=.694 |
| A_ne | 0.578 | V | |

| Parameter | Setting | Units |
|-------------------------|--------------------------|-------|
| package_tl_gamma0_a1_a2 | [0 0.0009909 0.0002772] | |
| package_tl_tau | 6.141E-03 | ns/mm |
| package_Z_c | [87.5 87.5 ; 92.5 92.5] | Ohm |