100G C2M Channel Model Update

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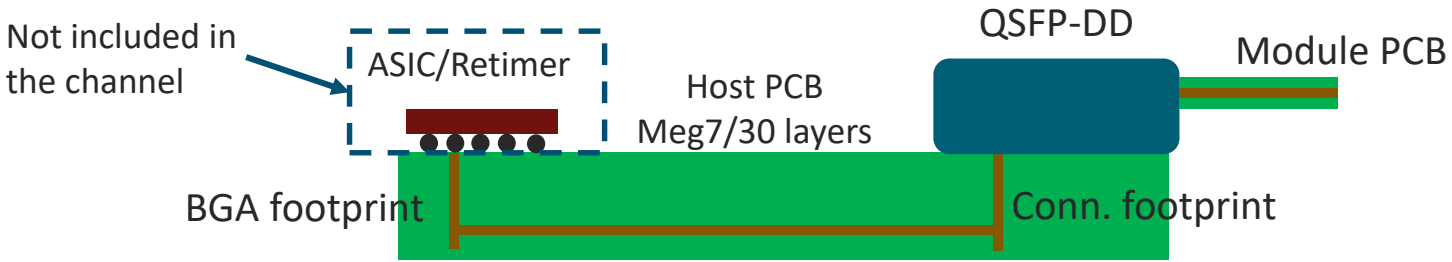
C2M Channel Model Update

- At September Spokane meeting, lim_3ck_01_0918 analyzed 12/14/16 dB C2M channels using QSFPDD connector, two sets of channels are provided on 07-Nov-2018
  - New QSFP-DD Channels: 12dB, 14dB, 16dB
  - Legacy QSFP-DD Channels: 12dB, 14dB, 16dB
- This presentation provides the improved C2M channel with optimized BGA & connector footprint including 112G QSFPDD SMT connector from Molex, and COM analysis at TP1a
- Both big size ASIC and retimer footprints are also considered
- Use latest COM scripts 2.59tryme (provided by Rich Mellitz on 2/27)

Model Overview

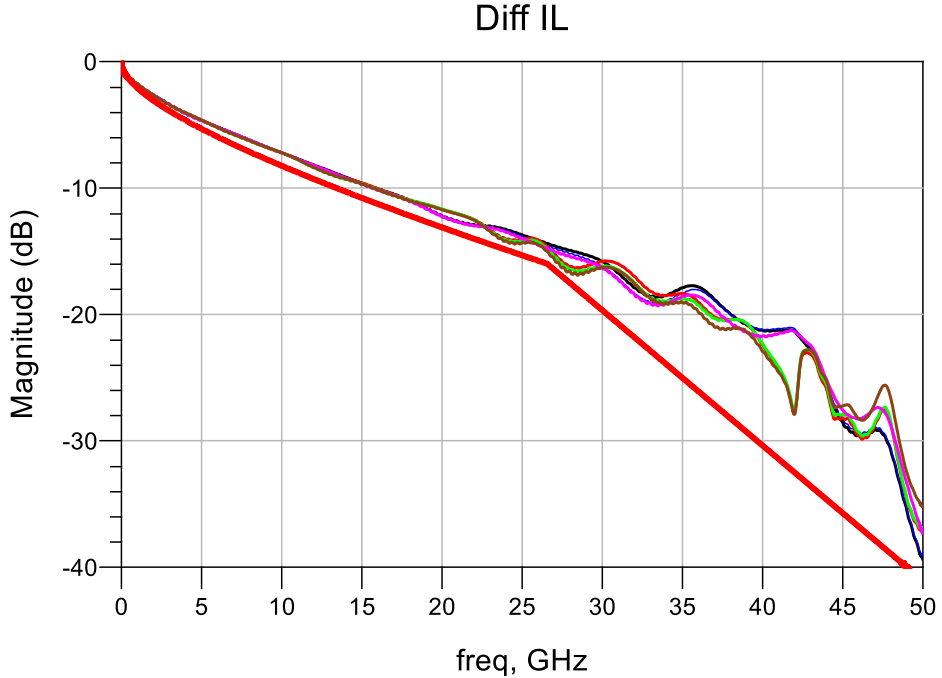
- 16 pairs (8 Tx, 8 Rx) QSFP-DD SMT Connector and host PCB footprint are solved as one piece in HFSS
  - QSFP-DD is the improved 112G simulation model, not the same as in today 56G part
- PCB stackup is 30 layers, 150mil thick, with Meg7 material
- PCB via stub length is modelled as 10mil
- Diff pair trace width/spacing is 4.5mil/8.5mil
- ASIC and retimer footprint are simulated with actual BGA ball-out using the same PCB stackup



Improved C2M Channels with 112G SMT Connector

- Total 6 channels were built :
  - Channel 1: Retimer BGA footprint (short via) + host PCB trace + QSFP-DD footprint & connector (new pad) + module PCB; including 2 FEXT & 2 NEXT
  - Channel 2: Retimer BGA footprint (long via) + host PCB trace + QSFP-DD footprint & connector (new pad) + module PCB; including 2 FEXT & 2 NEXT
  - Channel 3: Retimer BGA footprint (short via) + host PCB trace + QSFP-DD footprint & connector (legacy pad) + module PCB; including 2 FEXT & 2 NEXT
  - Channel 4: Retimer BGA footprint (long via) + host PCB trace + QSFP-DD footprint & connector (legacy pad) + module PCB; including 2 FEXT & 2 NEXT
  - Channel 5: ASIC BGA footprint (mid length via) + host PCB trace + QSFP-DD footprint & connector (new pad) + module PCB; including 5 FEXT & 3 NEXT
  - Channel 6: ASIC BGA footprint (mid length via) + host PCB trace + QSFP-DD footprint & connector (legacy pad) + module PCB; including 5 FEXT & 3 NEXT
- Channels can be found at -- http://www.ieee802.org/3/ck/public/tools/c2m/lim_3ck_01_0319_c2m.zip

Differential Insertion Loss



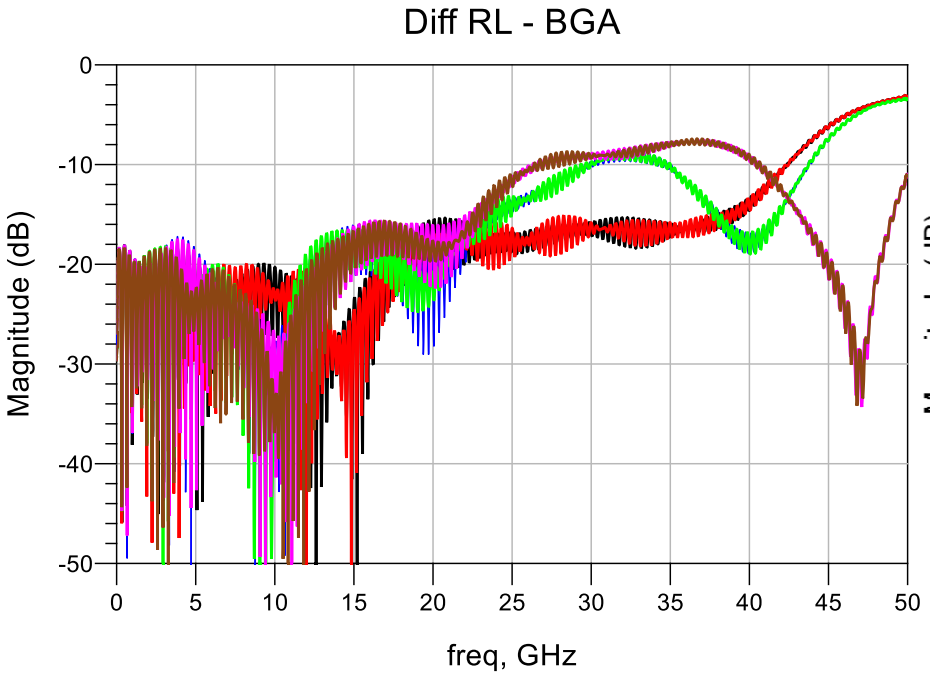
Channel1	Channel4
Channel2	Channel5
Channel3	Channel6

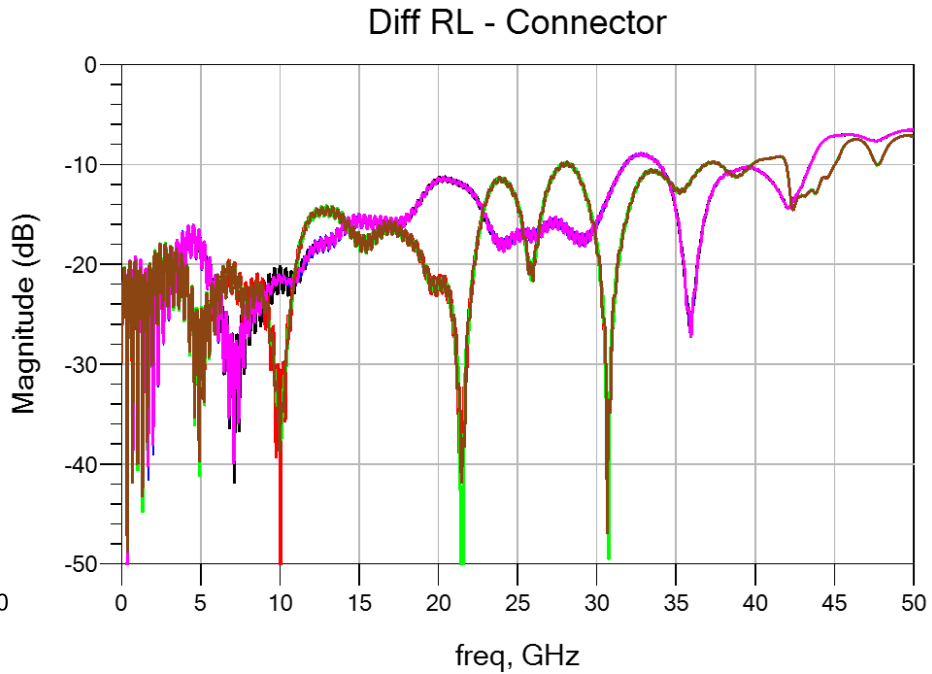
- IL limit derived from IEEE 802.3bs (Annex 120E)

$$\text{ILmax} = \begin{cases} 0.05 + 1.8\sqrt{f} + 0.2513f & 0.01 \le f \le 26.56, f \text{ in GHz} \\ -12.4192 + 1.07f & 26.56 < f \le 53.125 \end{cases}$$

Differential Return Loss

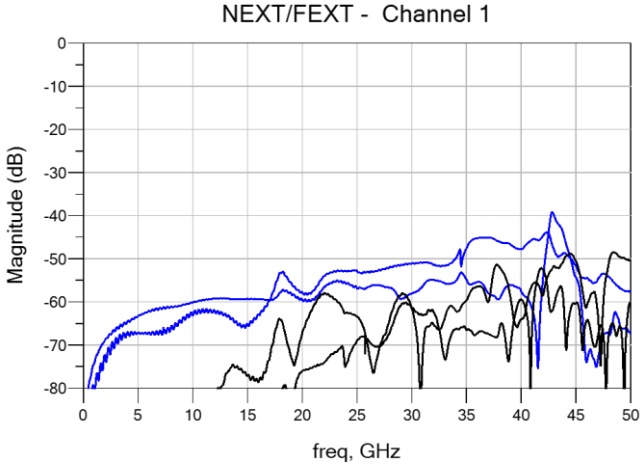
Channel1	Channel4
Channel2	Channel5
Channel3	Channel6

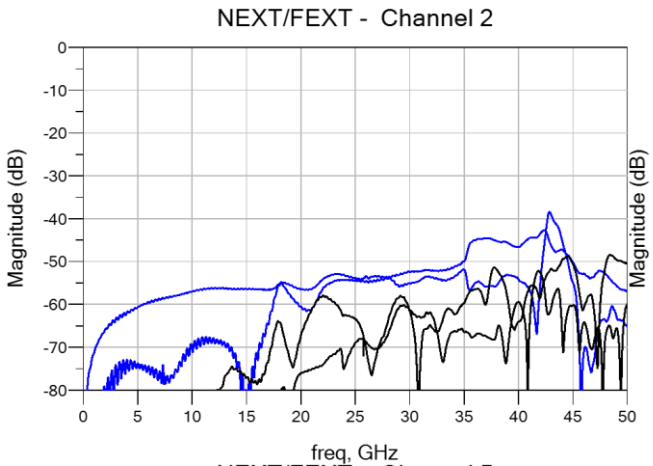


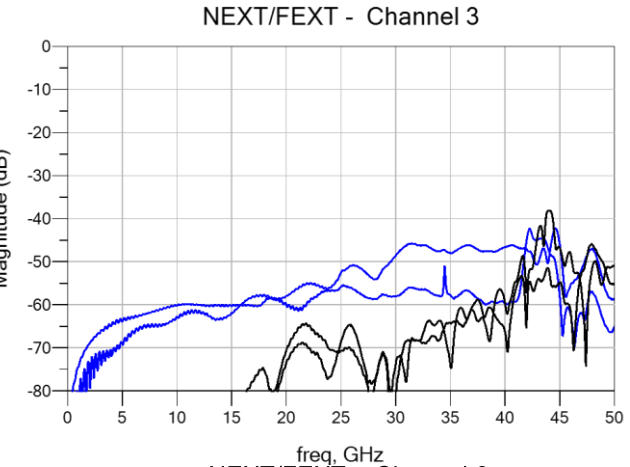


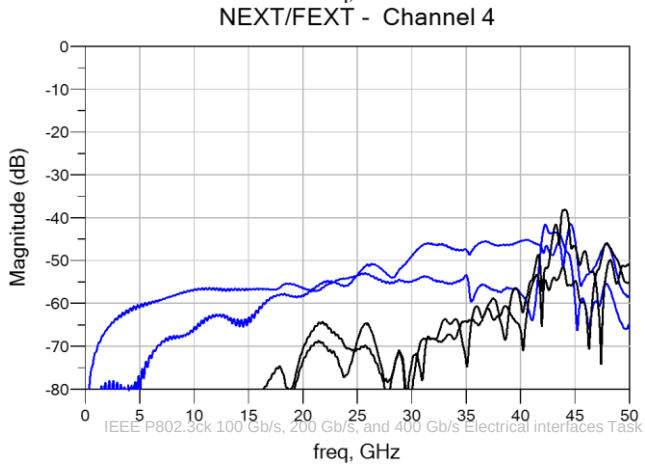
Far-end and Near-end Crosstalk

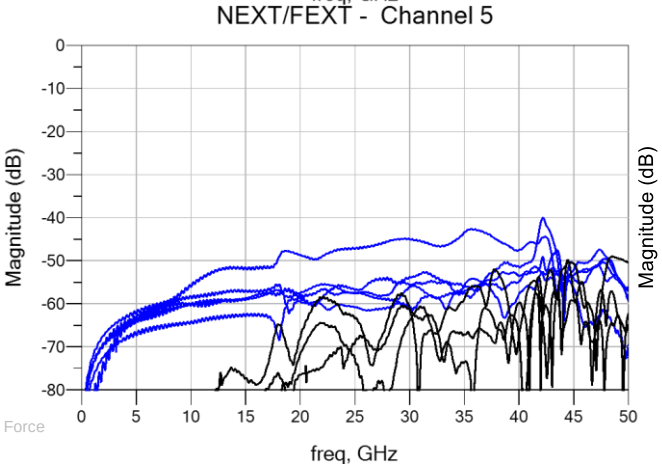
- NEXT aggressor
- FEXT aggressor

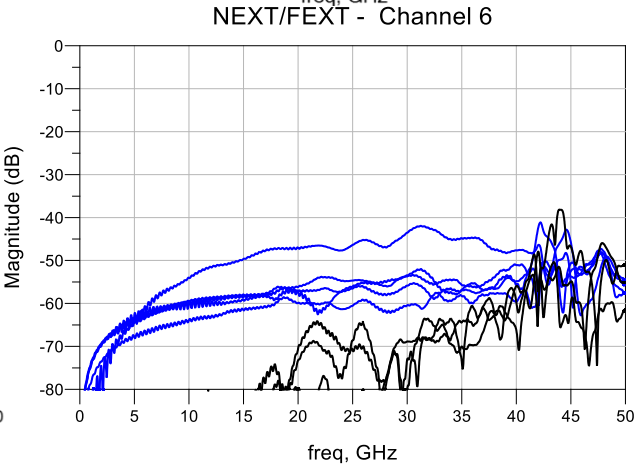












C2M TP1a COM Results, Channel 1-2-3-4

DUT	COM case 1	COM case 2	ERL11 (dB)	ERL22 (dB)	ICN (mV)	IL@26G (15mm)*	ILD
Channel 1 FFE4post	4.27	4.47	13.57	9.63	0.77	14.4/18.0	0.19
Channel 2 FFE4post	3.15	4.01	11.49	9.53	0.81	14.6/18.3	0.19
Channel 1 FFE4postDFE1	5.10	5.23	13.64	9.63	0.77	14.4/18.1	0.19
Channel 2 FFE4postDFE1	4.54	4.83	11.49	9.53	0.81	14.6/18.4	0.19
Channel 3 FFE4post	3.87	4.52	13.51	10.22	0.77	14.7/18.4	0.19
Channel 4 FFE4post	2.55	4.07	11.66	10.13	0.85	14.9/18.6	0.18
Channel 3 FFE4postDFE1	5.06	5.20	13.54	10.22	0.77	14.7/18.4	0.19
Channel 4 FFE4postDFE1	4.41	4.70	11.66	10.13	0.85	14.9/18.6	0.18

COM script 2.59tryme (2/27/2019)
config_100GEL_C2M_4dBpkg_baseline_tp1a_01a_ghiasi021319 (2/27/2019) – Cd has been modified to 130fF & Long Pckg 30mm
*IL@25.56GHz Channel without package/Channel with package

C2M TP1a COM Results, Channel 5-6

DUT	COM case 1	COM case 2	ERL11 (dB)	ERL22 (dB)	ICN (mV)	IL@26G (15mm)*	ILD
Channel 5 FFE4post	2.45	3.83	10.44	9.58	1.41	14.7/18.5	0.16
Channel 6 FFE4post	1.36	3.51	10.62	10.23	1.55	15.0/18.8	0.17
Channel 5 FFE4postDFE1	4.33	4.75	10.44	9.58	1.41	14.7/18.5	0.16
Channel 6 FFE4postDFE1	3.94	4.44	10.62	10.23	1.55	15.0/18.8	0.17

COM script 2.59tryme (2/27/2019)
config_100GEL_C2M_4dBpkg_baseline_tp1a_01a_ghiasi021319 (2/27/2019) – Cd has been modified to 130fF & Long Pckg 30mm
*IL@25.56GHz Channel without package/Channel with package

Summary

- Improved C2M channels are built with optimized BGA and connector footprints including 112G QSFP-DD connector
  - 400GAUI-4 C2M channel loss IL limit upto 16dB at 26.56GHz is derived from the channels
- QSFP-DD new pad has ~0.6dB worse ERL22 but slightly better IL/ILD/ICN than the legacy pad
- Overall channels have worse COM results on Case1 (15mm trace + 1.8mm PTH) than Case2 (30mm trace + 1.8mm PTH), especially for channel 6 with higher ICN (1.55mV)
- Channels built with ASIC footprint have higher ICN due to more aggressors present at BGA side
- All 6 channels can pass 3dB COM (Case2) at TP1a with CTLE + 5 tap FFE (1main, 4post) ref. receiver
- Channels 5&6 with ASIC footprint require CTLE + 5 tap FFE + 1 DFE tap to pass COM (Case1)

Backup Slides

Equalized Pulse Response Channel 1 and Channel 2