Next Step on 100G C2C-S and C2C-L

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List of Supporters

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Overview

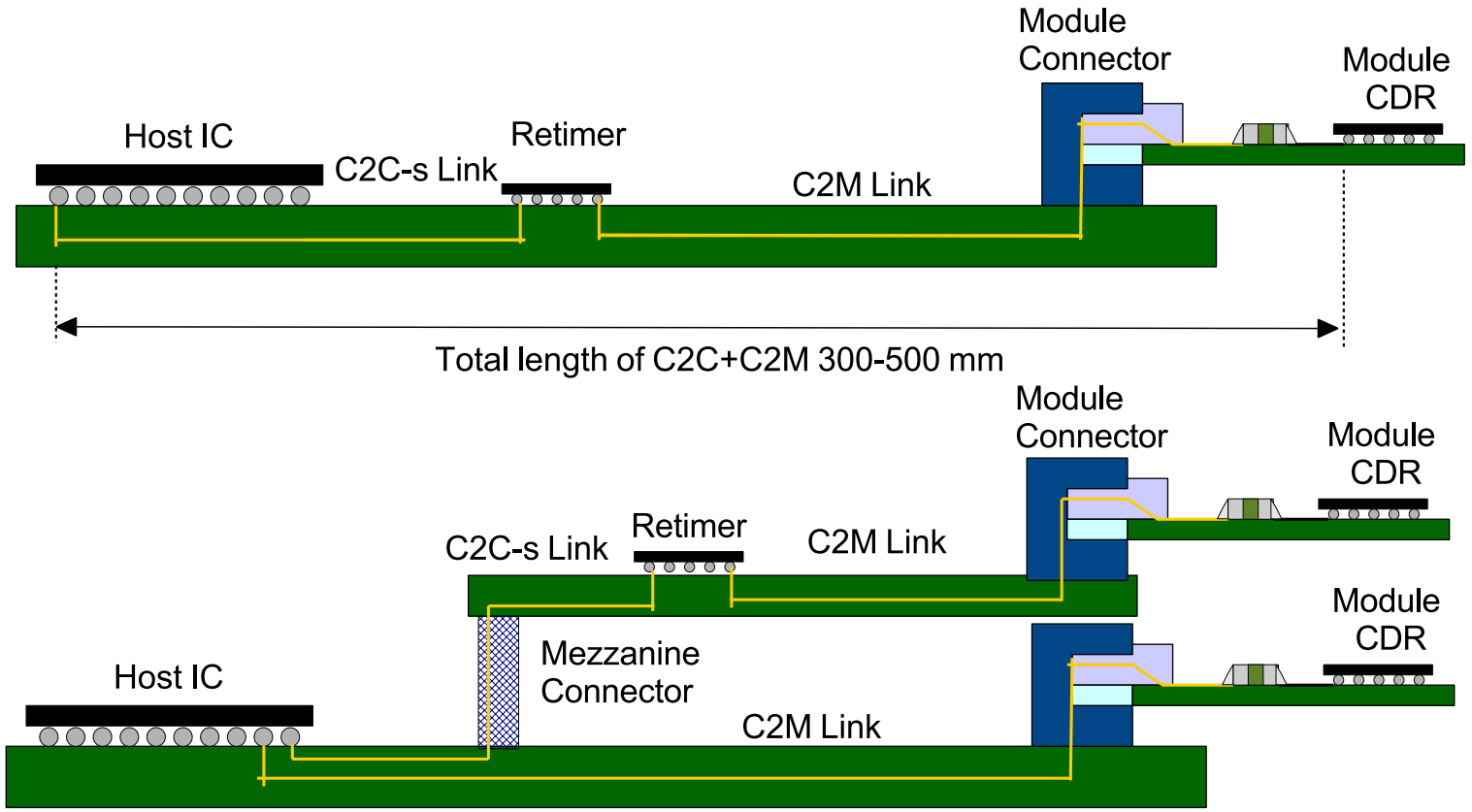
- Background
- C2C-S and C2C-L use case
- Test point and compliance
- Reference package
- COM tables
- Initial C2C-S and C2C-L COM analysis

Background

- **Use case and benefit of C2C-S interface in support of pluggable modules were presented in Bangkok**
  - http://www.ieee802.org/3/ck/public/18_11/ghiasi_3ck_01_1118.pdf
- **The advantage of C2C-S are**
  - Operating with single end-end FEC over 2 C2C-S links, plus 2 AUI links, and optical link
  - Avoid having 3 segmented FEC with 3x the latency
  - C2C-S link with <16 dB loss or ~300 mm will extend pluggable module range and support mezzanine card
  - C2C-S by not utilizing DFE or just light DFE can operate over end-end link transparently
  - C2C-S transparently will support 100 GbE non-interleaved FEC in support of optical PMDs
  - C2C-S transparently will support 200GbE/400GbE interleaved FEC in support of optical PMDs.

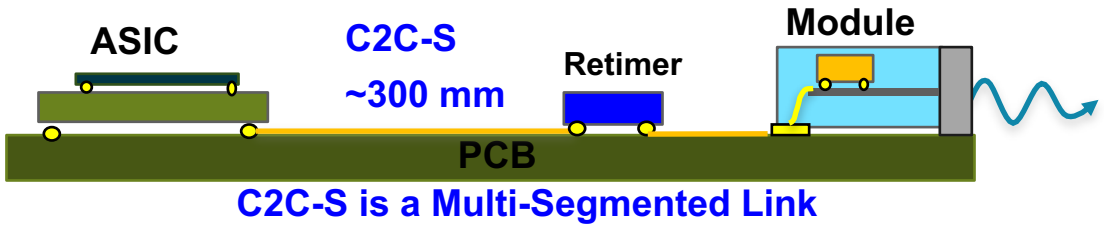
Two Common C2C-S Applications

- **These two common C2C-S applications can satisfied with ~300 mm trace and by repurposing 16 dB C2M budget**
  - Connecting to far-side of the ASIC IO may require retimer
  - Modules mounted on mezzanine card.

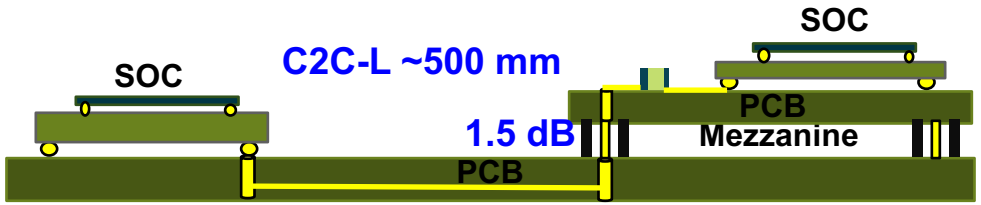


Key Differences Between C2C-S/L and KR

- C2C-S based on 16 dB C2M budget can support following reaches assuming Megtron 7 (1.3 dB/in) ~300 mm on PCB or ~280 mm on PCB with one connector
- C2C-L assuming ~500 mm reach on Megtron 7 (1.3 dB/in) with 1 connector (1.5 dB) results in 27.1 dB ball-ball budget
- KR supports 28 dB ball-ball with two connectors (3 dB) the reach on Megtron 7 (1.3 dB/in) is ~488 mm.



C2C-S is a Multi-Segmented Link



C2C-L is Point-Point Link

KR is Point-Point Link

Overview of C2C-S and C2C-L Attributes

- **C2C-S will leverage C2M link and reference equalizer**
- **C2C-L will leverage KR link and reference equalizer**

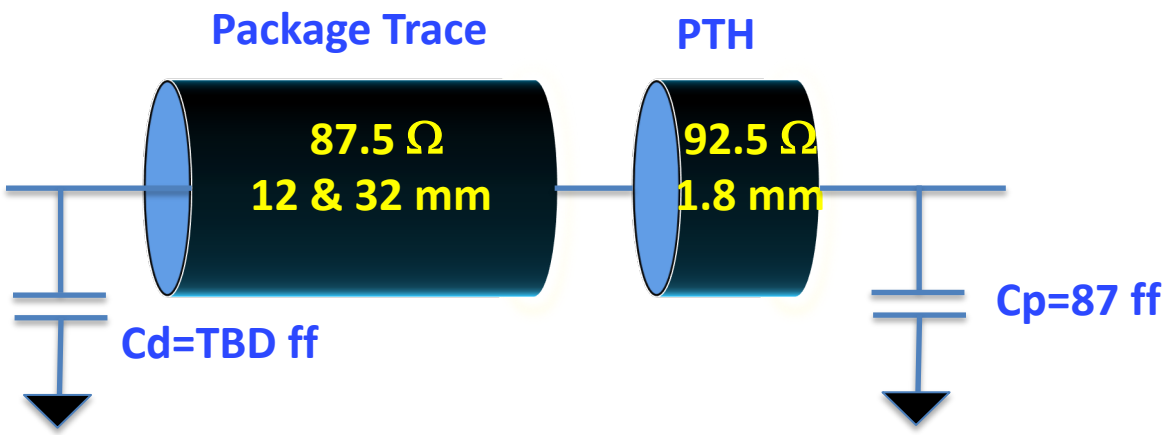
Parameters	C2M	C2C-S	KR	C2C-L
Chip configuration	ASIC to CDR	ASIC to CDR	ASIC to ASIC	ASIC to ASIC
Link configuration	One Connector	One Connector	Two Connectors	One Connector
Host PCB Reach (mm)	~225	~300	~500	~500
FEC operation	Pass Through	Pass Through	Terminated	Terminated
FEC Interleave/Non-Interleave	NA	Same as C2M	TBD for 100G	Same as KR
Back Channel Link Training	NA	NA	Required	Optional
ASIC, CDR Package Losses (dB)	4+1	4+1	4+4	4+4
Max channel loss at Nyquist (dB)	16	16	28	26.5*
Max Bump-Bump Loss (dB)	~21	~21	~36	~34.5
* C2C-L loss is lower by 1.5 dB compare to KR because the link only has one connector with about same PCB loss.				

C2C-S/L Test Point and Compliance

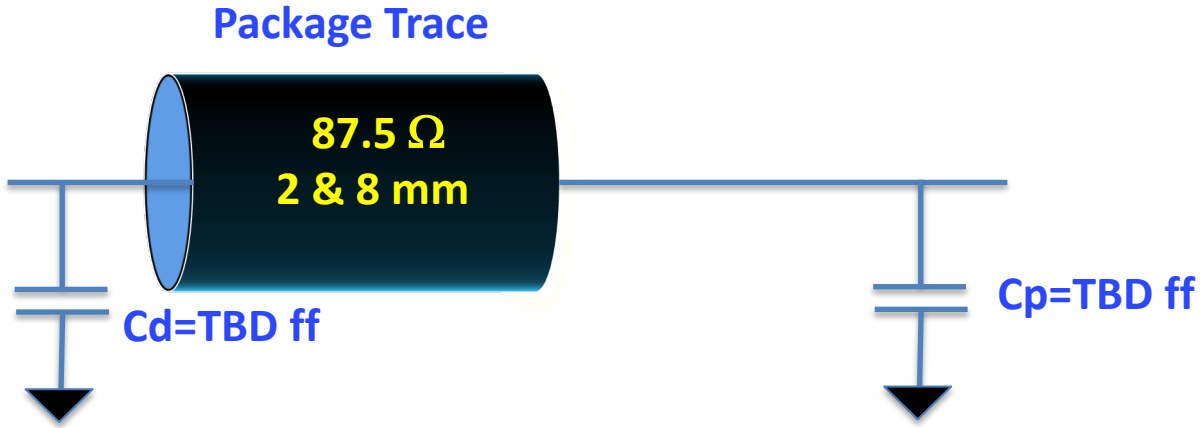
- **C2C-S test points are TP0a and TP5a**
  - C2M measurable test points TP1, TP4, TP1a, and TP4a are not applicable
  - MCB/HCB boards not applicable
- **Transmitter training**
  - Set based on loss/COM analysis or measurement
- **Compliance**
  - Channel compliance with COM
  - Receiver interference tolerance
  - Receiver jitter tolerance.
- **C2C-L test points are TP0a and TP5a identical to KR**
- **Transmitter training**
  - Set based on loss/COM analysis, measurement, or optional use KR link training
- **Compliance**
  - Channel compliance with COM
  - Receiver interference tolerance
  - Receiver jitter tolerance.

Reference Packages

- ASIC package



- CDR package has no PTH



COM Table for C2C-S/L

- **C2C-S will use C2M COM table area of possible exception:**
  - TP4a not applicable.
- **C2C-L will use KR COM table area possible exceptions:**
  - C(-3) if adopted for KR
  - Floating taps.

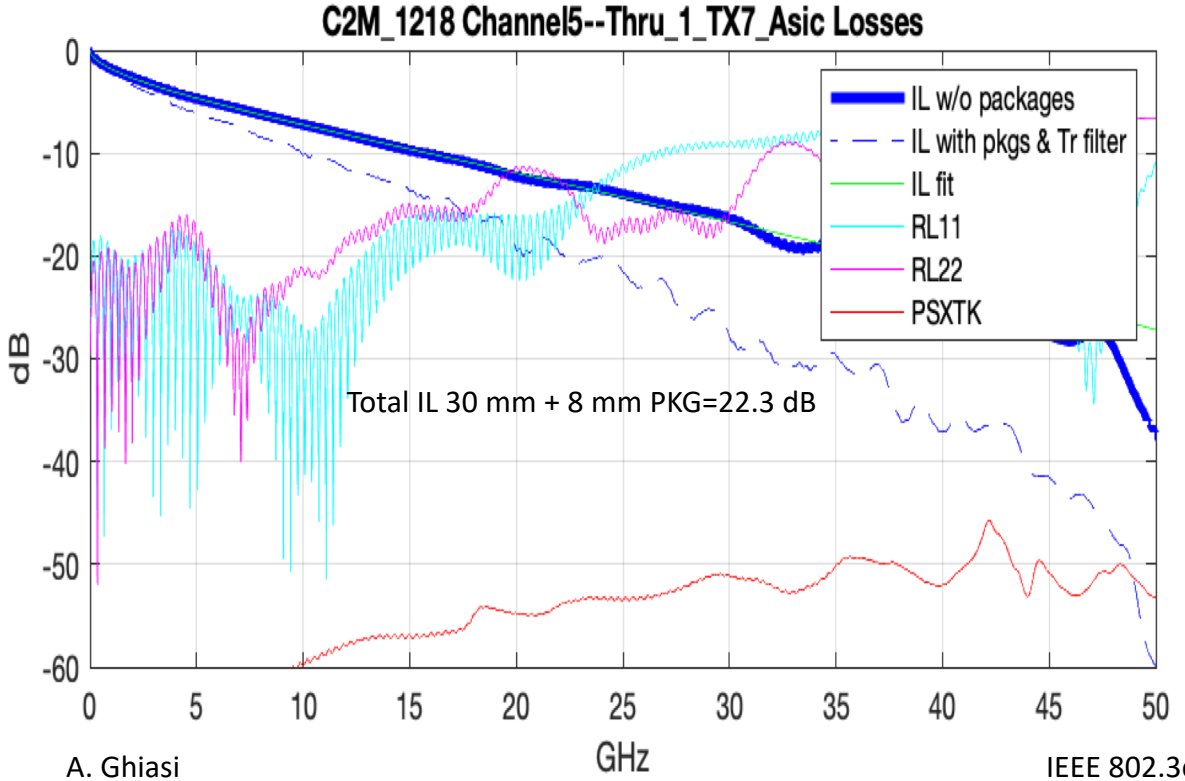
C2C-S COM Table

Table 93A-1 parameters					I/O control				Table 93A–3 parameters		
Parameter	Setting	Units	Information		DIAGNOSTICS	1	logical		Parameter	Setting	Units
f_b	53.1	GBd			DISPLAY_WINDOW	1	logical		package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
f_min	0.05	GHz			CSV_REPORT	1	logical		package_tl_tau	6.1400E-03	ns/mm
Delta_f	0.01	GHz			RESULT_DIR	.\results\100GEL_WG_{date}\			package_Z_c	[87.5 87.5]	Ohm
C_d	[0.85e-4 1.1e-4]	nF	[TX RX]		SAVE_FIGURES	0	logical				
z_p select	[1 2]		[test cases to run]		Port Order	[2 4 1 3]			Table 92–12 parameters		
z_p (TX)	[2 8]	mm	[test cases]		RUNTAG	C2M_1218			Parameter	Setting	
z_p (NEXT)	[2 8]	mm	[test cases]		COM_CONTRIBUTION	0	logical		board_tl_gamma0_a1_a2	[0 0.000599 0.0001022]	
z_p (FEXT)	[2 8]	mm	[test cases]		Operational				board_tl_tau	6.200E-03	ns/mm
z_p (RX)	[15 30]	mm	[test cases]		COM Pass threshold	1	dB		board_Z_c	90	Ohm
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]		ERL Pass threshold	5	dB		z_bp (TX)	50	mm
R_0	50	Ohm			DER_0	1.00E-05			z_bp (NEXT)	50	mm
R_d	[45 45]	Ohm	[TX RX]		T_r	6.16E-03	ns		z_bp (FEXT)	50	mm
A_v	0.41	V			FORCE_TR	1	logical		z_bp (RX)	0	mm
A_fe	0.41	V			Include PCB	0	logical				
A_ne	0.6	V			TDR and ERL options						
L	4				TDR	1	logical				
M	32				ERL	1	logical				
filter and Eq					ERL_ONLY	0	logical				
f_r	0.75	*fb			TR_TDR	0.01	ns				
c(0)	0.65		min		N	300					
c(-1)	[-0.2:0.02:0]		[min:step:max]	0.8	TDR_Butterworth	1	logical				
c(-2)	[0:.02:0.1]		[min:step:max]		beta_x	1.70E+09					
c(1)	[-0.1:0.02:0]		[min:step:max]		rho_x	0.18					
N_b	0	UI			fixture delay time	0					
b_max(1)	0.5				TDR_W_TXPKG	1					
b_max(2..N_b)	0.2				N_bx	4	UI				
g_DC	[-14:0.5:-4]	dB	[min:step:max]		Receiver testing						
f_z	18.55345912	GHz			RX_CALIBRATION	0	logical				
f_p1	53.1	GHz			Sigma BBN step	5.00E-03	V				
f_p2	28.2	GHz									
g_DC_HP	[-3:0.5:-1]		[min:step:max]		Noise, jitter						
f_HP_PZ	1.3275	GHz			sigma_RJ	0.01	UI				
ffe_pre_tap_len	0	UI			A_DD	0.02	UI				
ffe_post_tap_len	4	UI			eta_0	8.20E-09	V^2/GHz				
ffe_tap_step_size	0				SNR_TX	33	dB				
ffe_main_cursor_min	0.7				R_LM	0.95					
ffe_pre_tap1_max	0.3										
ffe_post_tap1_max	0.3										
ffe_tapn_max	0.2										
ffe_backoff	1										

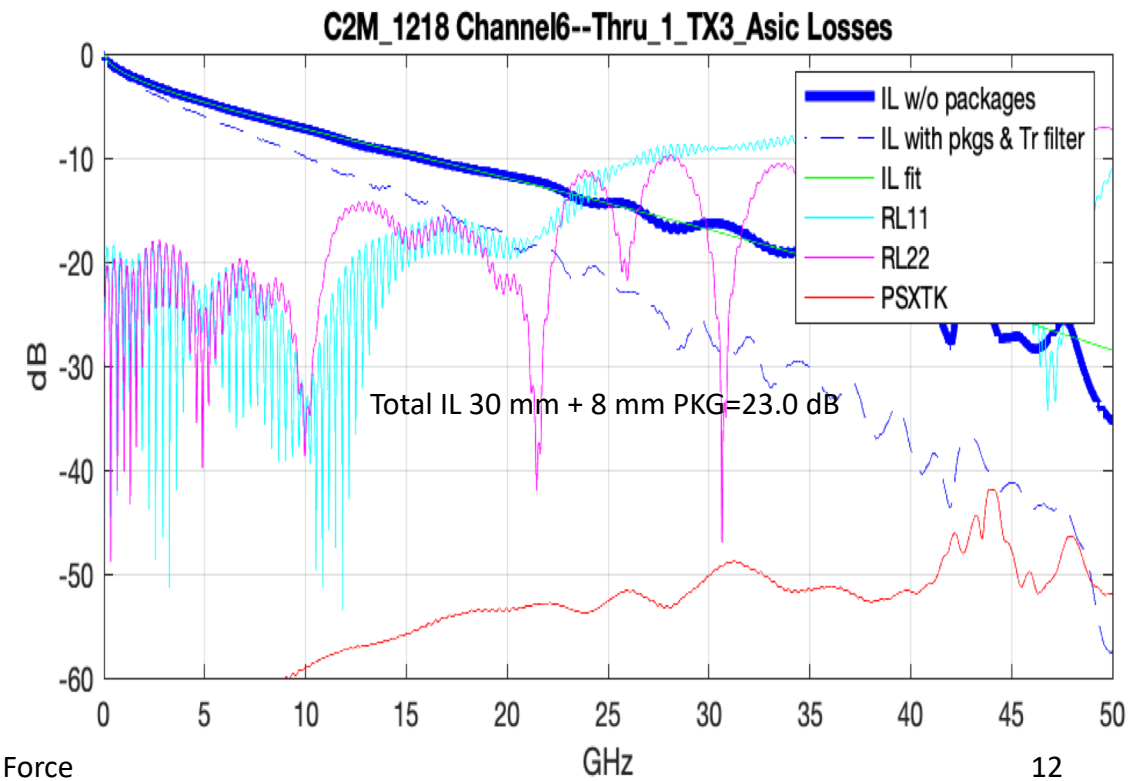
C2C-S COM Analysis

- **Due to lack of C2C-S channel Lim C2M channels which include ASIC foot print and QSFP-dd connector are used for COM analysis**
  - http://www.ieee802.org/3/ck/public/tools/c2m/lim_3ck_01_0319_c2m.zip

Lim Channel 5, FOM_ILD=0.16, ICN=1.4 mV, ICR=38.2 dB, , ERL11=16.2, ERL22=9.8
5T FFE(4 post): COM=2.1 (1.9) dB, EH=7.0 (4.9) mV, VEC=13.2 (14.1) dB
5T FFE(4 post)+1DFE: COM=4.0 (3.4) dB, EH=16.4 (11.4) mV, VEC=8.9 (9.8) dB
4DFE: COM=3.7 (3.5) dB, EH=14.1 (11.3) mV, VEC=7.9 (9.6) dB



Channel 6, FOM_ILD=0.17, ICN=1.6 mV, ICR=36.8 dB, , ERL11=16.6, ERL22=10.4
5T FFE(4 post): COM=1.4 (3.8) dB, EH=4.3 (8.4) mV, VEC=16.5 (9.0) dB
5T FFE(4 post)+1DFE: COM=3.7 (4.8) dB, EH=19.7 (14.4) mV, VEC=7.8 (7.5) dB
4DFE: COM=3.5 (4.5) dB, EH=12.0 (13.4) mV, VEC=9.5 (7.9) dB



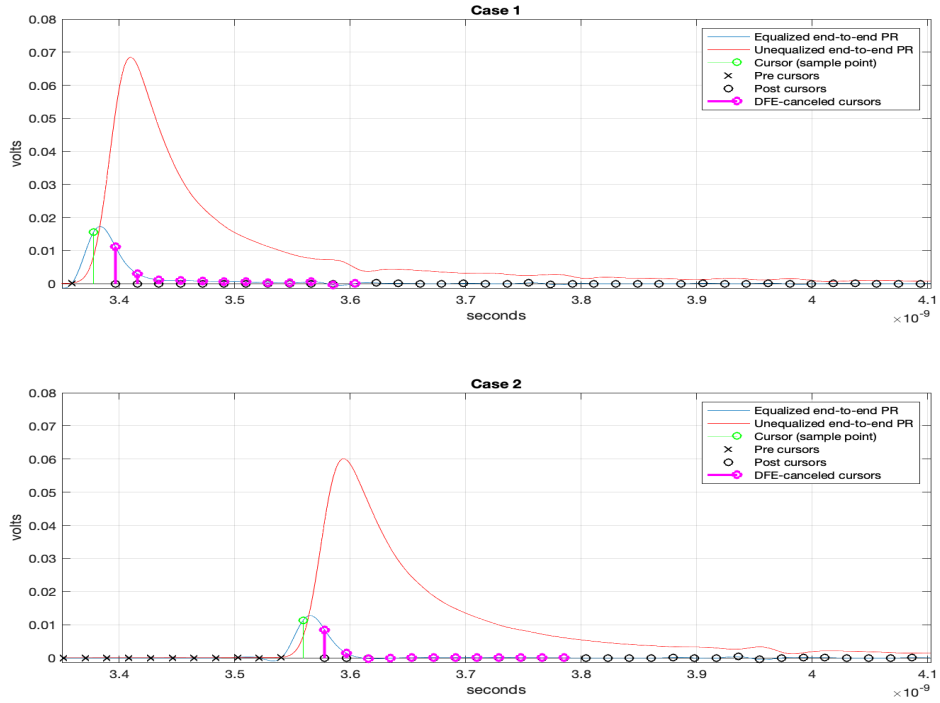
C2C-L COM Table

Table 93A-1 parameters					I/O control				Table 93A–3 parameters		
Parameter	Setting	Units	Information		DIAGNOSTICS	1	logical		Parameter	Setting	Units
f_b	53.1	GBd			DISPLAY_WINDOW	1	logical		package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
f_min	0.05	GHz			CSV_REPORT	1	logical		package_tl_tau	6.1400E-03	ns/mm
Delta_f	0.01	GHz			RESULT_DIR	.\results\100GEL_WG_{date}\			package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm
C_d	[1.2e-4 1.2e-4]	nF	[TX RX]		SAVE_FIGURES	0	logical				
z_p select	[1 2]		[test cases to run]		Port Order	[1 3 2 4]			Table 92–12 parameters		
z_p (TX)	[15 30; 1.8 1.8]	mm	[test cases]		RUNTAG	C2M_1218			Parameter	Setting	
z_p (NEXT)	[15 30; 1.8 1.8]	mm	[test cases]		COM_CONTRIBUTION	0	logical		board_tl_gamma0_a1_a2	[0 0.000599 0.0001022]	
z_p (FEXT)	[15 30; 1.8 1.8]	mm	[test cases]		Operational				board_tl_tau	6.200E-03	ns/mm
z_p (RX)	[15 30; 1.8 1.8]	mm	[test cases]		COM Pass threshold	-3	dB		board_Z_c	90	Ohm
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]		ERL Pass threshold	0	dB		z_bp (TX)	235	mm
R_0	50	Ohm			DER_0	1.00E-04			z_bp (NEXT)	235	mm
R_d	[45 45]	Ohm	[TX RX]		T_r	6.16E-03	ns		z_bp (FEXT)	235	mm
A_v	0.413	V			FORCE_TR	1	logical		z_bp (RX)	0	mm
A_fe	0.413	V			Include PCB	1	logical				
A_ne	0.608	V			TDR and ERL options						
L	4				TDR	1	logical				
M	32				ERL	1	logical				
filter and Eq					ERL_ONLY	0	logical				
f_r	0.75	*fb			TR_TDR	0.01	ns				
c(0)	0.54		min		N	300					
c(-1)	[-0.34:0.02:0]		[min:step:max]		TDR_Butterworth	1	logical				
c(-2)	[0:.02:0.12]		[min:step:max]		beta_x	1.70E+09					
c(1)	[-0.2:0.02:0]		[min:step:max]		rho_x	0.25					
N_b	12	UI			fixture delay time	0					
b_max(1)	0.75				TDR_W_TXPKG	1					
b_max(2..N_b)	0.25				N_bx	4	UI				
g_DC	[-14:0.5:-4]	dB	[min:step:max]		Receiver testing						
f_z	21.24	GHz			RX_CALIBRATION	0	logical				
f_p1	53.1	GHz			Sigma BBN step	5.00E-03	V				
f_p2	21.24	GHz									
g_DC_HP	[-6:1:0]		[min:step:max]		Noise, jitter						
f_HP_PZ	0.66375	GHz			sigma_RJ	0.01	UI				
ffe_pre_tap_len	0	UI			A_DD	0.02	UI				
ffe_post_tap_len	0	UI			eta_0	8.20E-09	V^2/GHz				
ffe_tap_step_size	0				SNR_TX	33	dB				
ffe_main_cursor_min	0.7				R_LM	0.95					
ffe_pre_tap1_max	0.35										
ffe_post_tap1_max	0.35										
ffe_tapn_max	0.2										
ffe_backoff	1										

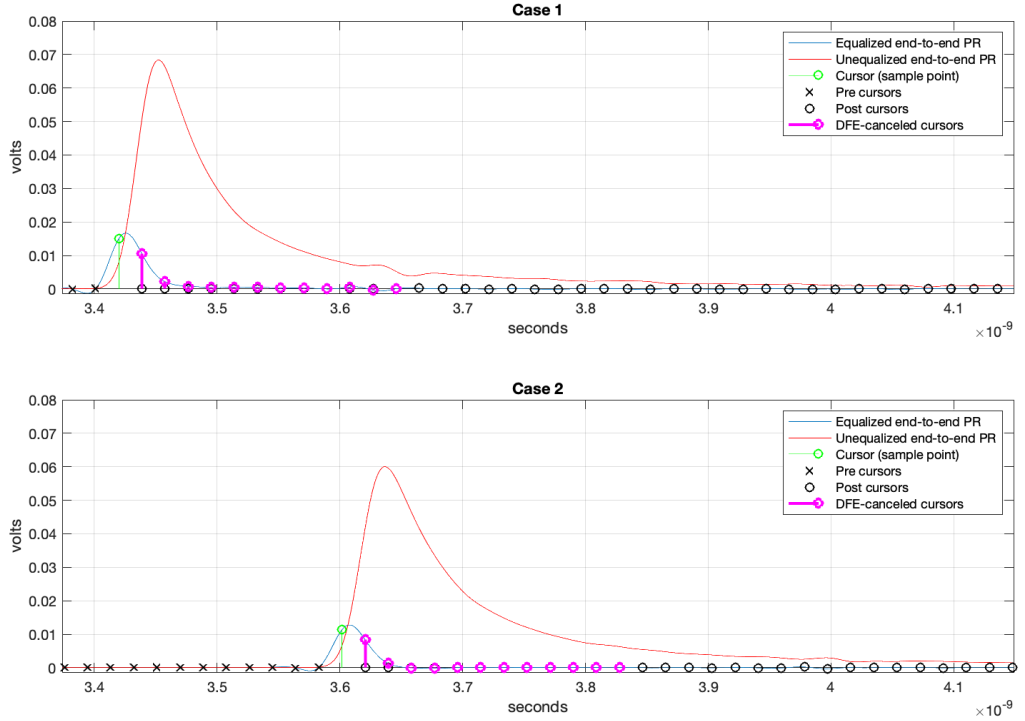
C2C-L COM Analysis

- **Due to lack of C2C-L channels Lim C2M channels which include ASIC foot print and QSFP-dd connector with addition of 232 mm are used for COM analysis**
  - http://www.ieee802.org/3/ck/public/tools/c2m/lim_3ck_01_0319_c2m.zip

Channel 5, FOM_ILD=0.16, ICN=0.48 mV, ICR=38 dB, , ERL11=16.4, ERL22=10.5
12 Tap DEF: COM=5.4 (3.3) dB, VEO=4.6 (2.3) mV, VEC=6.7 (10.0) dB
Total IL for Lim Channel 5+232 mm 26.5 dB, IL with packages 36.5 dB



Channel 6, FOM_ILD=0.19, ICN=0.52 mV, ICR=36.7 dB, , ERL11=16.7, ERL22=11.2
12 Tab DFE: COM=5.6 (4.2) dB, VEO=4.5 (2.7) mV, VEC=6.5 (8.4) dB
Total IL for Lim Channel 5+232 mm 26.8 dB, IL with packages 37.3 dB



Summary

- **We currently have no C2C-S and C2C-L channels**
  - Instead Lim C2M channels with ASIC foot print are used for C2C-S analysis and with addition of 232 mm for C2C-L analysis
- **C2C-S will leverage C2M specifications**
  - C2C-S supports 16 dB channel with one connector
  - Test points for C2C-S are TP0a and TP5a
  - Supports one 32 mm long ASIC two segment package plus one CDR 8 mm long single segment package
  - C2C-S transmitter FFE is set based on COM and/or empirical measurements similar to C2M
  - COM will be used as channel compliance
  - Reference equalizer TBD
- **There are enough difference between C2C-L and KR that we should define an AUI clause instead of making C2C-L a subset of KR applications, below are key attributes of C2C-L**
  - C2C-L supports 26.5 dB channel with one connector
  - Compliance points and test method based on KR
  - Supports two 32 mm long two segments ASIC package
  - C2C-L may not use C(-3)
  - Link training might be optional for C2C-L
  - COM will be used as channel compliance
  - COM reference equalizer KR CTLE + N tap DFE
- **Recommend the task force to define two AUI clauses one for C2C-S and 2nd AUI clause for C2C-L.**