

On-die Termination Model Comparison for C2M

Junqing (Phil) Sun, Credo Semiconductor

Simulation Settings

- Simulations are set to study termination difference while keep all the other parameters the same.

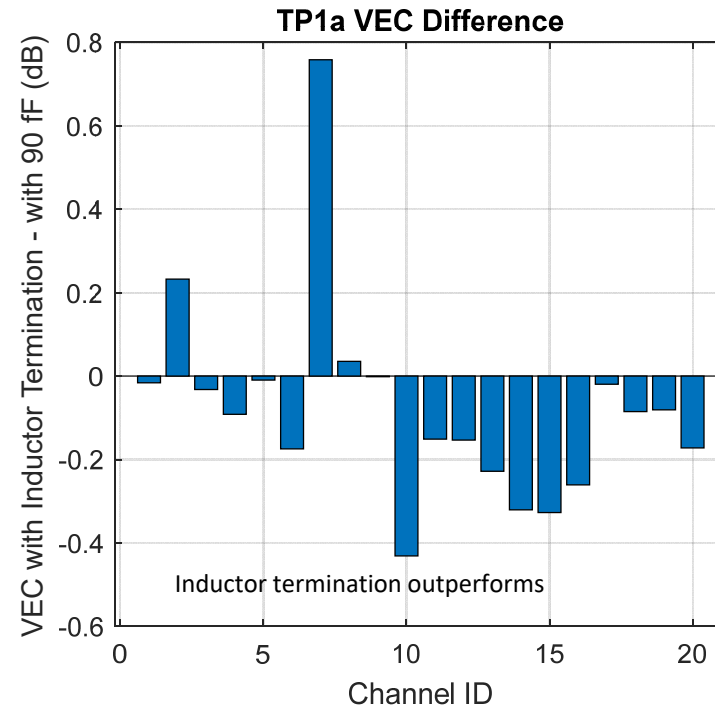
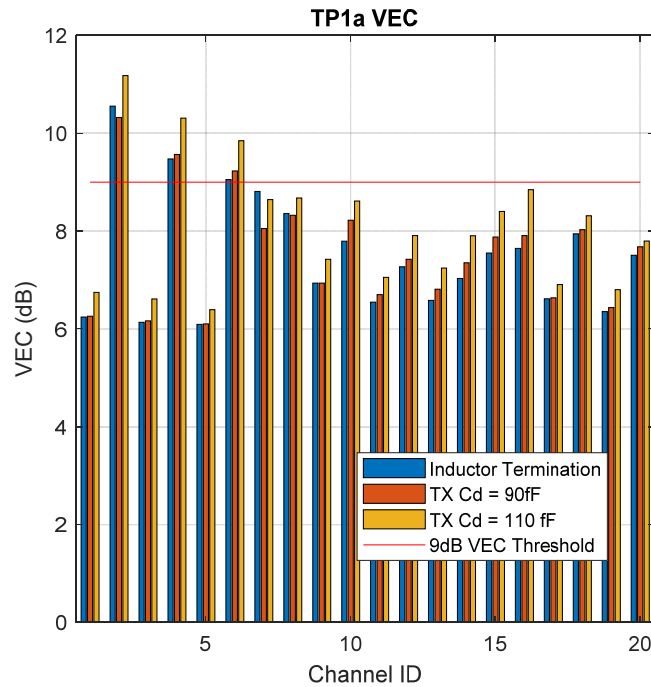
Termination Scheme for host	<u>healey 3ck adhoc 01 061219</u> (with inductor)	Cd 90 fF	Cd 110 fF
Ls	120 pH	0 pH	0 pH
Cb	30 fF	0 fF	0 fF
Cd	120 fF	90 fF	110 fF
Cp	87 fF	87 fF	87 fF
Package trace length	Scan every 1 mm to find the worst		

- Reference receivers review:

- A: 4-tap DFE (tap 1-4, $b_{1max}=0.5$)
- B: 5 tap FFE with 4 post + 1-tap DFE with $b_{1max}=0.5$
- C: 5-tap FFE with 4 post
 - C2: 3-tap FFE with 2 post
- D: 3-tap DFE (tap 2, 3, 4)
 - D2: 1-tap DFE (tap 2)

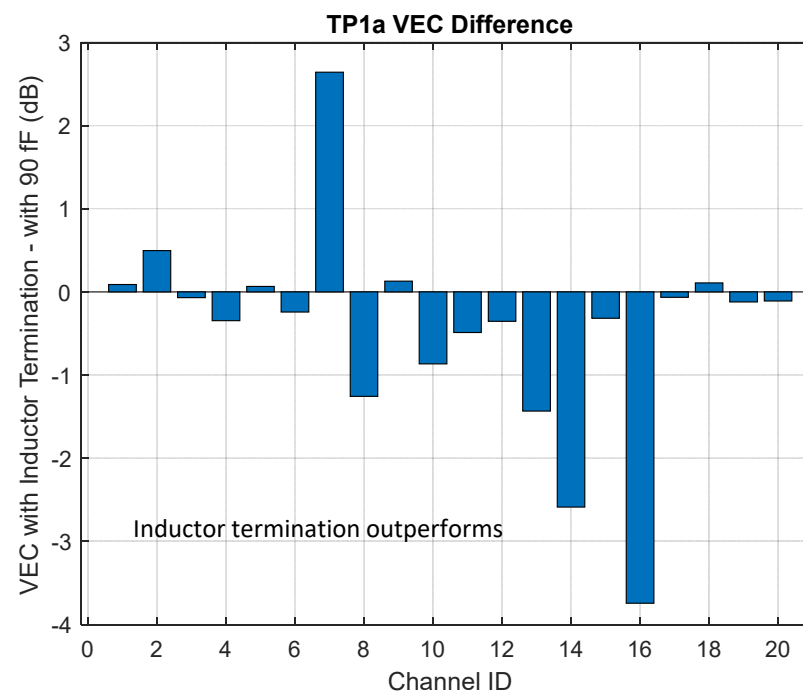
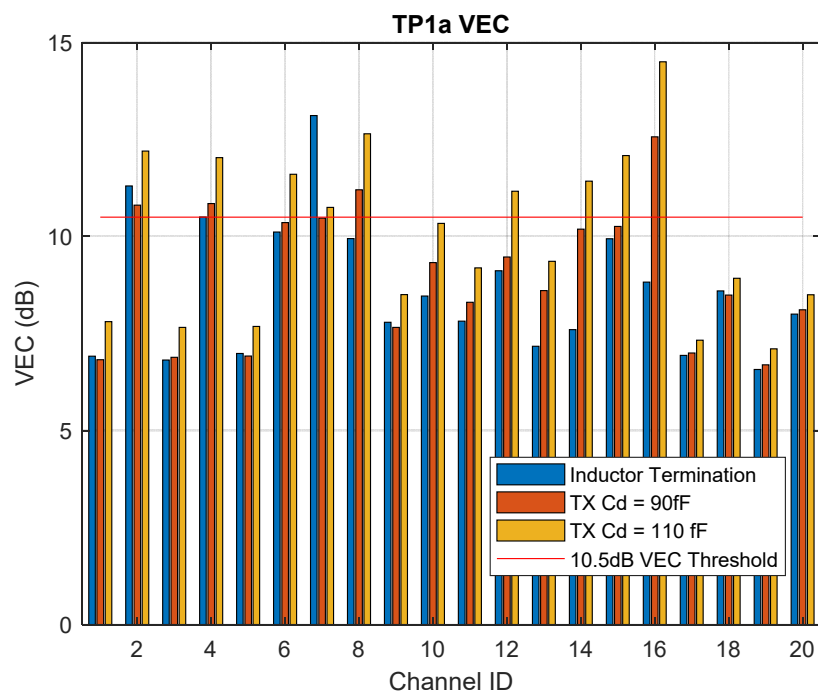
* Note D and D2 do not have post tap 1.

TP1a VEC with RX A



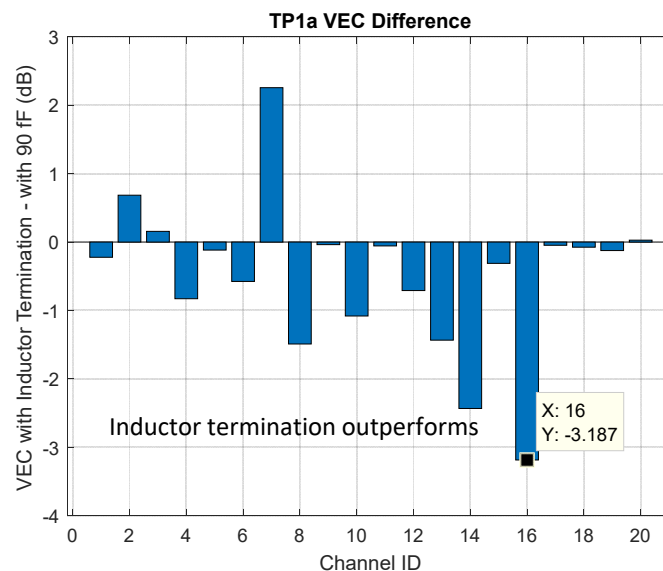
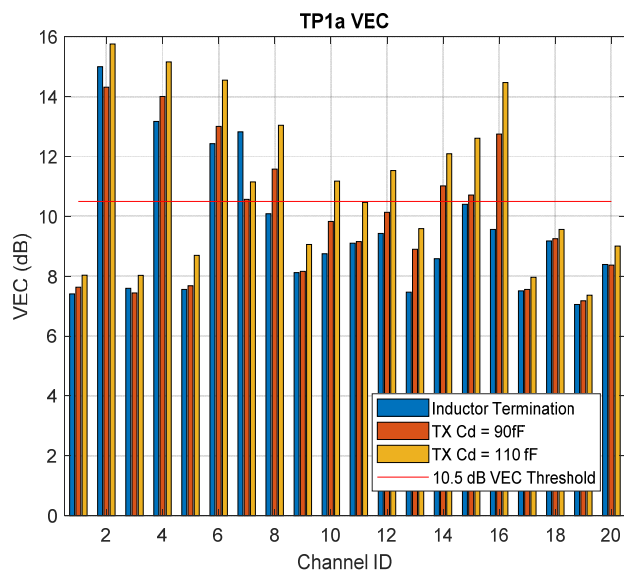
- With Reference receiver A (4-tap DFE, $b_{1max}=0.5$)
- Termination with inductors (Adam's proposal) outperforms Cd 90fF for most of the channels by up to 0.43dB.
 - Channel 7 is an exception.
- Receiver A is relatively insensitive to termination difference.
- If VEC threshold is set to 8dB, channels 2, 4, 6, 7, 8 are excluded.

TP1a VEC with RX C



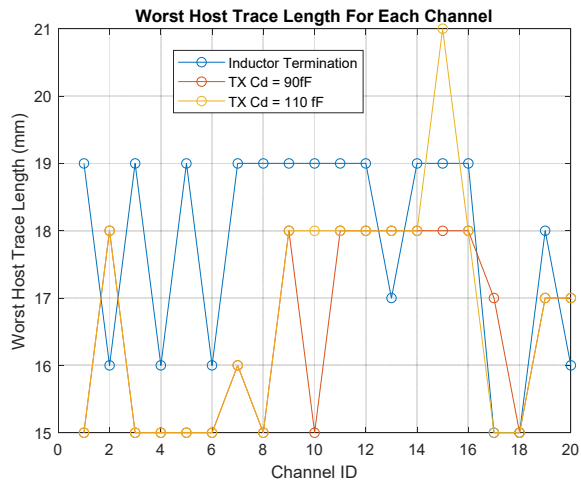
- With Reference receiver C – 4 post-tap FFE
- Inductor termination out performs Cd=90 fF for most channels by up to 3.7dB.
- With receiver C, channels 2, 4, 6 and channels 8, 15 VEC are close to each other.
 - If VEC threshold is set to 9.5 dB, channels 2, 4, 6, 7, 8, and 15 will not be supported.

TP1a VEC with RX D2

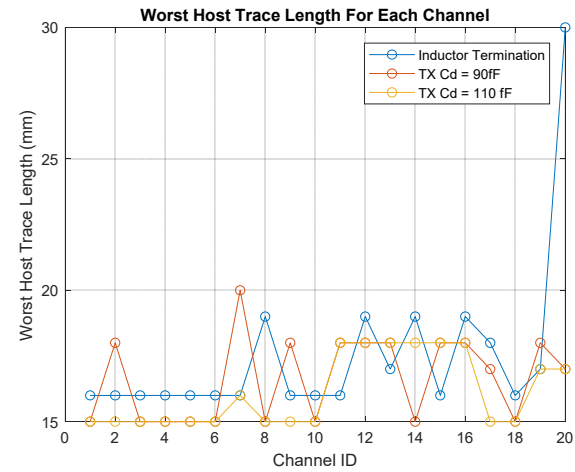


- With Reference receiver D2 – 1 tap DFE (post 2)
- Inductor termination out performs Cd=90 fF for most channels by up to 3.2dB.
- VEC threshold can be set to ~10.5 dB to exclude channels 2, 4, 6, 7.

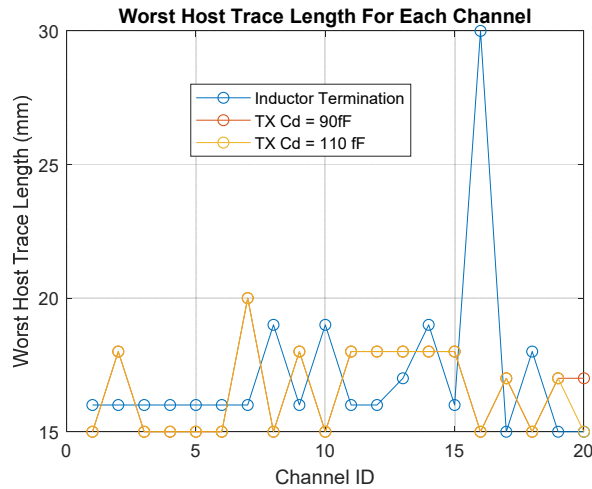
Worst Host Trace Length



With Reference receiver A – 4 post-tap DFE

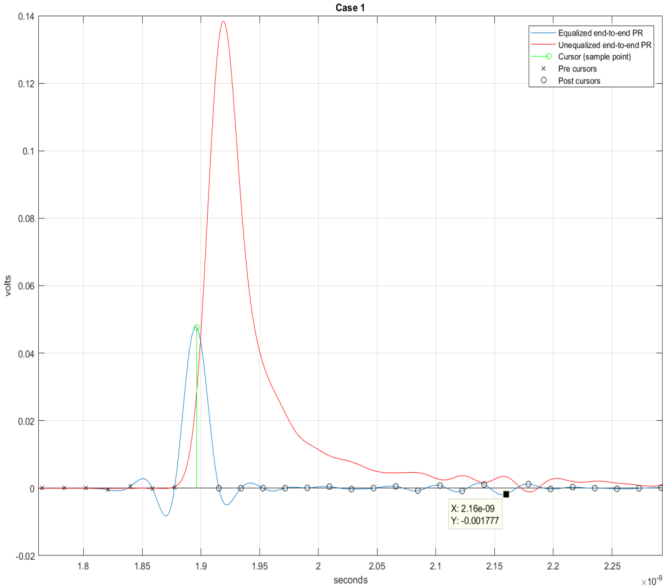


With Reference receiver D2 – 1-tap DFE on post 2

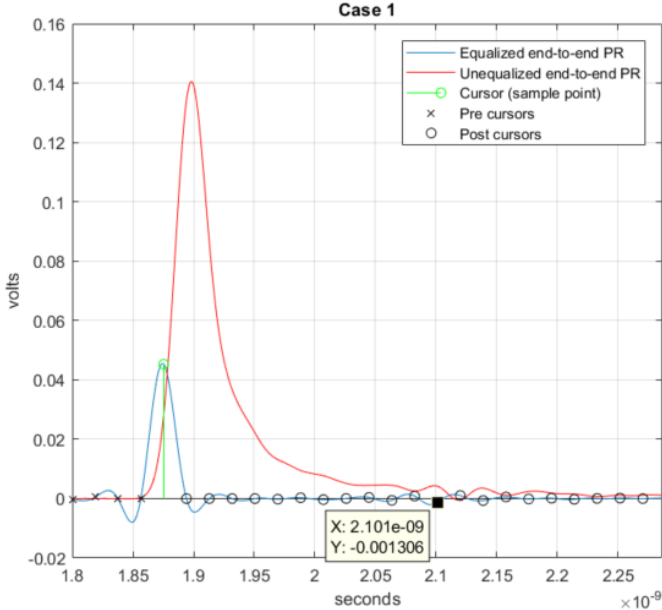


With Reference receiver C – 4 post-tap FFE

Channel 7 Pulse Response



With inductor termination



With Cd 90 fF

- Host package reflection is the major contributor of VEC difference.

Summary

- With inductor termination, weaker reference receivers C/C2/D/D2 become sufficient for TP1a.
- With weaker reference receivers C/C2/D/D2, inductor termination outperforms 90 fF Cd for channels the group voted to support.
 - Receivers A and B are relatively insensitive to termination model difference.

Backup Slides

COM Spread Sheet – TP1a With Ref RX C2

Table 93A-1 parameters				I/O control			Table 93A-3 parameters			
Parameter	Setting	Units	Information	DIAGNOSTICS			Parameter	Setting	Units	
f_b	53.125	GBd		DISPLAY_WINDOW	0	logical	package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]		
f_min	0.05	GHz		CSV_REPORT	1	logical	package_tl_tau	6.141E-03	ns/mm	
Delta_f	0.01	GHz		RESULT_DIR	.\TestCaseFloatingBank\		package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm	
C_d	[1.2e-4, 0]	nF	[TX RX]	SAVE_FIGURES	0	logical	Table 92-12 parameters			
L_s	[0.12, 0]	nH	[TX RX]	Port Order	[1 3 2 4]		Parameter	Setting		
C_b	[0.3e-4 0]	nF	[TX RX]	RUNTAG	testPkg		board_tl_gamma0_a1_a2	[0 3.8206e-04 9.5909e-05]		
z_p_select	[1]		[test cases to run]	COM_CONTRIBUTION	0	logical	board_tl_tau	5.790E-03	ns/mm	
z_p (TX)	[16 30; 1.8 1.8]	mm	[test cases]	Operational			board_Z_c	90	Ohm	
z_p (NEXT)	[0 0; 0 0]	mm	[test cases]	COM Pass threshold	3	dB	z_bp (TX)	119	mm	
z_p (FEXT)	[16 30; 1.8 1.8]	mm	[test cases]	ERL Pass threshold	10.5	dB	z_bp (NEXT)	119	mm	
z_p (RX)	[0 0; 0 0]	mm	[test cases]	DER_0	1.00E-05		z_bp (FEXT)	119	mm	
C_p	[0.87e-4 0]	nF	[TX RX]	T_r	6.16E-03	ns	z_bp (RX)	119	mm	
R_0	50	Ohm		FORCE_TR	1	logical				
R_d	[45, 50]	Ohm	[TX RX]	Include PCB	0	logical				
A_v	0.391	V	vp/vf=.694	TDR and ERL options						
A_fe	0.391	V	vp/vf=.694	TDR	1	logical				
A_ne	0.489	V		ERL	1	logical				
L	4			ERL_ONLY	0	logical				
M	32			TR_TDR	0.01	ns				
filter and Eq				N	400					
f_r	0.75	*fb		TDR_Butterworth	1	logical				
c(0)	0.6		min	beta_x	0.00E+00					
c(-1)	[-0.3:0.02:0]		[min:step:max]	rho_x	0.32					
c(-2)	[0:.02:0.1]		[min:step:max]	fixture delay time	0	enter sec				
c(-3)	[-0.04:0.02:0.0]		[min:step:max]	TDR_W_TXPKG	1					
c(1)	[-0.1:0.05:0]		[min:step:max]	N_bx	4	UI				
N_b	0	UI		Receiver testing						
b_max(1)	0			RX_CALIBRATION	0	logical				
b_max(2..N_b)	0.2			Sigma BBN step	5.00E-03	V				
g_DC	[-14:1:-3]	dB	[min:step:max]	Noise, jitter						
f_z	12.58	GHz		sigma_RJ	0.01	UI				
f_p1	20	GHz		A_DD	0.02	UI				
f_p2	28	GHz		eta_0	8.20E-09	V^2/GHz				
g_DC_HP	[-3:1:0]		[min:step:max]	SNR_TX	33	dB				
f_HP_PZ	1.328125	GHz		R_LM	0.95					
ffe_pre_tap_len	0	UI								
ffe_post_tap_len	2	UI								
ffe_tap_step_size	0									
ffe_main_cursor_min	0.7									
ffe_pre_tap1_max	0.3									
ffe_post_tap1_max	0.3									
ffe_tapn_max	0.125									
ffe_backoff	0									

COM Spread Sheet – TP1a With Ref RX D2

Table 93A-1 parameters				I/O control			Table 93A-3 parameters		
Parameter	Setting	Units	Information	DIAGNOSTICS		logical	Parameter	Setting	Units
f_b	53.125	GBd		DISPLAY_WINDOW	0	logical	package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
f_min	0.05	GHz		CSV_REPORT	1	logical	package_tl_tau	6.141E-03	ns/mm
Delta_f	0.01	GHz		RESULT_DIR	.\TestCaseFloatingBank\		package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm
C_d	[1.2e-4, 0]	nF	[TX RX]	SAVE_FIGURES	0	logical	Table 92-12 parameters		
L_s	[0.12, 0]	nH	[TX RX]	Port Order	[1 3 2 4]		Parameter	Setting	
C_b	[0.3e-4 0]	nF	[TX RX]	RUNTAG	testPkg		board_tl_gamma0_a1_a2	[0 3.8206e-04 9.5909e-05]	
z_p_select	[1]		[test cases to run]	COM_CONTRIBUTION	0	logical	board_tl_tau	5.790E-03	ns/mm
z_p (TX)	[16 30; 1.8 1.8]	mm	[test cases]	Operational			board_Z_c	90	Ohm
z_p (NEXT)	[0 0; 0 0]	mm	[test cases]	COM Pass threshold	3	dB	z_bp (TX)	119	mm
z_p (FEXT)	[16 30; 1.8 1.8]	mm	[test cases]	ERL Pass threshold	10.5	dB	z_bp (NEXT)	119	mm
z_p (RX)	[0 0; 0 0]	mm	[test cases]	DER_0	1.00E-05		z_bp (FEXT)	119	mm
C_p	[0.87e-4 0]	nF	[TX RX]	T_r	6.16E-03	ns	z_bp (RX)	119	mm
R_0	50	Ohm		FORCE_TR	1	logical			
R_d	[45, 50]	Ohm	[TX RX]	Include PCB	0	logical			
A_v	0.391	V	vp/vf=.694	TDR and ERL options					
A_fe	0.391	V	vp/vf=.694	TDR	1	logical			
A_ne	0.489	V		ERL	1	logical			
L	4			ERL_ONLY	0	logical			
M	32			TR_TDR	0.01	ns			
filter and Eq				N	400				
f_r	0.75	*fb		TDR_Butterworth	1	logical			
c(0)	0.6		min	beta_x	0.00E+00				
c(-1)	[-0.3:0.02:0]		[min:step:max]	rho_x	0.32				
c(-2)	[0:0.02:0.1]		[min:step:max]	fixture delay time	0	enter sec			
c(-3)	[-0.04:0.02:0.0]		[min:step:max]	TDR_W_TXPKG	1				
c(1)	[-0.1:0.05:0]		[min:step:max]	N_bx	4	UI			
N_b	2	UI		Receiver testing					
b_max(1)	0			RX_CALIBRATION	0	logical			
b_max(2..N_b)	0.2			Sigma BBN step	5.00E-03	V			
g_DC	[-14:1:-3]	dB	[min:step:max]	Noise, jitter					
f_z	12.58	GHz		sigma_RJ	0.01	UI			
f_p1	20	GHz		A_DD	0.02	UI			
f_p2	28	GHz		eta_0	8.20E-09	V^2/GHz			
g_DC_HP	[-3:1:0]		[min:step:max]	SNR_TX	33	dB			
f_HP_PZ	1.328125	GHz		R_LM	0.95				
ffe_pre_tap_len	0	UI							
ffe_post_tap_len	0	UI							
ffe_tap_step_size	0								
ffe_main_cursor_min	0.7								
ffe_pre_tap1_max	0.3								
ffe_post_tap1_max	0.3								
ffe_tapn_max	0.125								
ffe_backoff	0								

May Straw Poll Results

Channel Information

Recommendation	ID	Channel Description	IL (dB)	ERL11 (dB)	ERL22 (dB)	ICN (mV)	FOM ILD	RX Required for TP1a		RX Required for Modules		
								A, B	C, D	A, B	C	FFE12Post
Pass	1	mellitz_3ck_01_0518_C2M\9dB	8.95	16.35	12.82	2.28	0.10	Pass	Pass	Pass	Marginal	Pass
Fail	2	mellitz_3ck_01_0518_C2M\10dB	9.96	7.79	10.41	4.53	0.48	Fail	Fail	Fail	Fail	Fail
Pass	3	mellitz_3ck_01_0518_C2M\11dB	11.16	18.28	14.13	1.93	0.09	Pass	Pass	Pass	Marginal	Pass
Fail	4	mellitz_3ck_01_0518_C2M\12dB	12.18	8.39	11.29	3.99	0.46	Fail	Fail	Fail	Fail	Fail
Pass	5	mellitz_3ck_01_0518_C2M\13dB	13.12	20.09	14.85	1.68	0.09	Pass	Pass	Pass	Marginal	Pass
Fail	6	mellitz_3ck_01_0518_C2M\14dB	13.87	8.73	12.52	3.19	0.47	Fail	Fail	Fail	Fail	Fail
TBD	7	tracy_100GEL_02_0118\long_barrel_via\TX5	16.48	14.98	11.58	0.91	0.28	Pass	Fail	Pass	Fail	Marginal
TBD	8	tracy_100GEL_02_0118\long_barrel_via\TX6	16.08	14.35	12.61	0.90	0.37	Marginal	Fail	Fail	Fail	Fail
Pass	9	tracy_100GEL_06_0118\Microvia\RX6	14.59	15.71	12.50	0.83	0.21	Pass	Pass	Pass	Marginal	Pass
TBD	10	tracy_100GEL_06_0118\Microvia\RX5	14.57	16.20	13.45	0.93	0.23	Marginal	Fail	Pass	Marginal	Marginal
Pass	11	lim_3ck_01_0319_QDD_new_pad\ch1	14.40	15.83	20.69	0.78	0.20	Pass	Pass	Marginal	Fail	Fail
Pass	12	lim_3ck_01_0319_QDD_new_pad\ch2	14.60	14.51	20.20	0.82	0.19	Pass	Marginal	Marginal	Fail	Fail
Pass	13	lim_3ck_01_0319_QDD_legacy_pad\ch3	14.69	16.04	15.98	0.77	0.20	Pass	Marginal	Pass	Marginal	Pass
Pass	14	llim_3ck_01_0319_QDD_legacy_pad\ch4	14.84	14.77	15.72	0.86	0.18	Pass	Fail	Pass	Marginal	Pass
TBD	15	llim_3ck_01_0319_QDD_new_pad\ch5	14.77	14.70	20.57	1.42	0.16	Pass	Fail	Marginal	Fail	Fail
Pass	16	llim_3ck_01_0319_QDD_legacy_pad\ch6	15.02	15.01	15.90	1.55	0.17	Pass	Fail	Pass	Fail	Pass
Pass	17	ito_3ck_01\QSFP \bottom normal\	15.10	12.79	10.75	1.20	0.18	Pass	Pass	Pass	Marginal	Pass
TBD	18	ito_3ck_01\QSFP \bottom worst\	15.58	12.49	10.35	1.14	0.32	Marginal	Marginal	Marginal	Fail	Pass
Pass	19	ito_3ck_01\QSFP \top normal\	14.53	12.76	10.85	1.25	0.18	Pass	Pass	Pass	Pass	Pass
TBD	20	ito_3ck_01\QSFP \top worst\	14.49	12.43	10.37	1.21	0.31	Pass	Pass	Pass	Fail	Pass

- Parameters highlighted in red are worse than 10.5dB ERL, 2.5mV ICN, or 0.35dB ILD.
- ERL is reported with the settings for reference receiver with 15mm package and 4-tap DFE at TP1a. ERL11 is for channel only. ERL22 is at TP1a including TX package.
- Channel names in red are tough channels for most of the receivers.
- For receiver pass/fail results, 15mm and 30mm host package traces are considered. Marginal means fail but close to the thresholds (violate by less than 0.5 dB).

5

IEEE P802.3ck Task Force

Sun_3ck_01_0519

http://www.ieee802.org/3/ck/public/19_05/lusted_3ck_02_0519.pdf