Revisit TP1a EH and VEC based on New Test Method in IEEE 802.3ck D1p4

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For IEEE 802.3ck

Supporters

Outlines

- Background
- Channel & Analysis
- Impact from New Test Method in D1p4
- TP1a vs Whole-Link Correlation
- Summary & Proposals

Background

- New test method of C2M TP1a EH/VEC had been adopted in 802.3ck D1p4
  - Proposed in healey_3ck_02_1020
  - EH/VEC specs in D1p4 are not valid any more
- Run COM analysis based on new method in D1p4 to derive new EH/VEC specs
  - Adopt similar analysis as wu_3ck_01a_1119
- Proposals for Table 120G-1
  - VEC = 12 dB for TP1a
  - EH = 8 mV for TP1a
- This is an updated version from wu_3ck_adhoc_01_010621
  - To response suggestions from ad-hoc meeting
  - Mark the updated content by pink

Channel and Analysis

- Channel (crosstalk included) and reference receiver
  - Whole-link & TP1a analysis for total nineteen IEEE C2M host-to-module channels
    - Sweep host package trace length, z_p1(TX)
      - z_p1(TX) = [5:0.5:10 11:1:20 22:2:36]
    - Total 19 * 29 = 551 CH+PKG test cases
- COM parameter settings [details in appendix]
  - COM 3.1
  - Whole link: TX Device/PKG + H2M Channels + RX PKG/Device

C_d	[1.2e-4 0.85e-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)	[xx ; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[2 8 ; 0 0]	mm	[test cases]
z_p (FEXT)	[xx ; 1.8 1.8]	mm	[test cases]
z_p (RX)	[2 8 ; 0 0]	mm	[test cases]
C_p	[0.87e-4 0.65e-4]	nF	[TX RX]

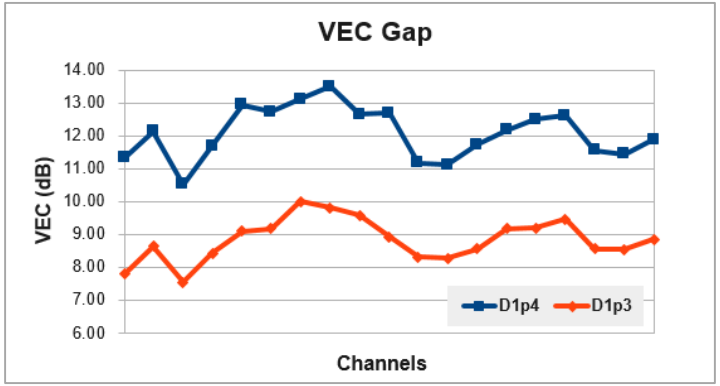
  - TP1a: TX Device/PKG + H2M Channels
    - Set ‘zero’ to related RX PKG & on-die settings

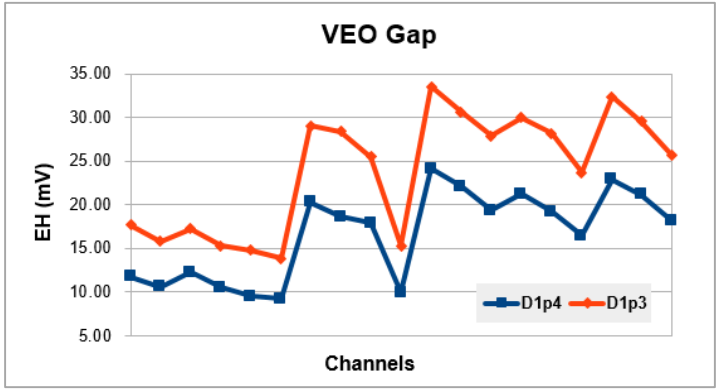
Impacts to COM, EH & VEC from New Test Method Adopted by D1p4 – D1p3 vs. D1p4

- Considerations of the following parameter changes from D1p3 to D1p4
  - EH/VEC methodology: T_O = 25 → 50 mUI
- Observations
  - EH & VEC does degrade based on new method

TP1a Analysis – Impact to VEC & VEO (EH)

				VEC (dB)		EH (mv)	
				D1p4	D1p3	D1p4	D1p3
lim_3ck_01a_0319	lim_3ck_01_0319_c2m.zip	Tx7_L10	112G_16dB_(QSFPDD+module card)_TX7_L10	11.32	7.79	11.76	17.65
		Tx7_L23	112G_16dB_(QSFPDD+module card)_TX7_L23	12.13	8.64	10.56	15.78
		Tx3_L10	112G_16dB_(QSFPDD+module card)_TX3_L10	10.51	7.54	12.24	17.23
		Tx3_L23	112G_16dB_(QSFPDD+module card)_TX3_L23	11.69	8.42	10.49	15.30
		Tx7_Asic	112G_16dB_(QSFPDD+module card)_TX7_Asic	12.93	9.10	9.51	14.78
		Tx3_Asic	112G_16dB_(QSFPDD+module card)_TX3_Asic	12.73	9.18	9.20	13.85
lim_3ck_adhoc_01_	073119 lim_3ck_adhoc_02_073119.zip	Ch5a_2"	Channel5a_Smaller_Pad_2inch_trace	13.12	10.00	20.30	29.06
		Ch5b_3"	Channel5b_Smaller_Pad_3inch_trace	13.48	9.81	18.60	28.40
		Ch5c_4"	Channel5c_Smaller_Pad_4inch_trace	12.64	9.58	17.91	25.47
		Ch5d_9"	Channel5d_Smaller_Pad_9inch_trace	12.69	8.92	9.93	15.32
akinwale_3ck_adhoc_01a_08282019	akinwale_3ck_C2M_channels_TP0a_100ohms_08222019.zip	2''100Ohm	C2M_2p0in_100Ohm_thru1.s4p	11.17	8.31	24.09	33.49
		3''100Ohm	C2M_3p0in_100Ohm_thru1.s4p	11.12	8.27	22.07	30.62
		4''100Ohm	C2M_4p0in_100Ohm_thru1.s4p	11.73	8.57	19.35	27.86
	akinwale_3ck_C2M_channels_TP0a_85ohms_08222019.zip	2''85Ohm	C2M_2p0in_85Ohm_thru1.s4p	12.17	9.17	21.21	29.96
		3''85Ohm	C2M_3p0in_85Ohm_thru1.s4p	12.50	9.19	19.22	28.14
		4''85Ohm	C2M_4p0in_85Ohm_thru1.s4p	12.60	9.46	16.48	23.66
	akinwale_3ck_C2M_channels_TP0a_95Ohms_08222019.zip	2''95Ohm	C2M_2p0in_95Ohm_thru1.s4p	11.55	8.56	22.91	32.33
		3''95Ohm	C2M_3p0in_95Ohm_thru1.s4p	11.44	8.54	21.14	29.54
		4''95Ohm	C2M_4p0in_95Ohm_thru1.s4p	11.88	8.85	18.15	25.72
			Diff (D1p3 as basis)	3.24		-7.32	





Summary of Impacts from New Test Method

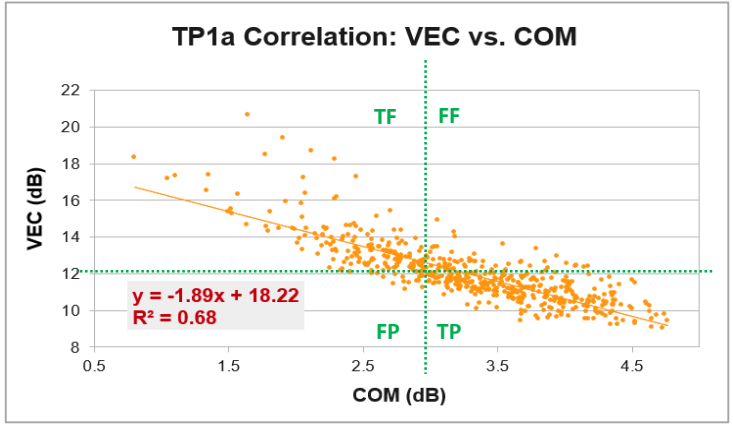
- Difference of VEC, & EH
  (D1p4 – D1p3)

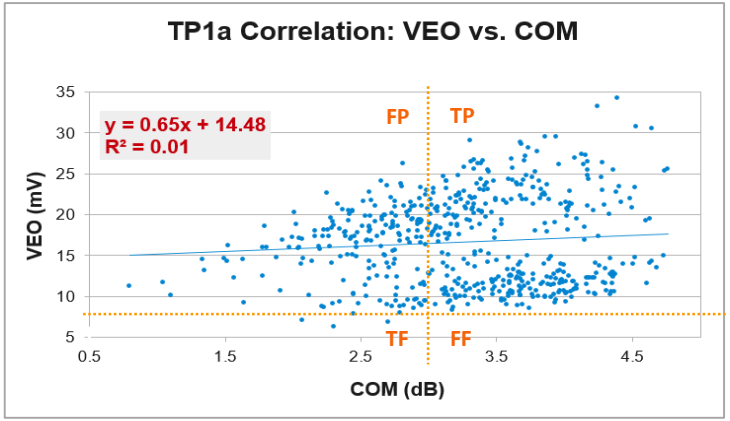
Item	Difference
VEC	3.24 dB
EH	-7.32 mV

EH/VEC vs. COM Correlation – Check Correlation

- T_O = 0 mUI for COM
  - Take COM >= **3** dB as pass indicator
- Correlation of COM and VEC/VEO
  - VEC (dB) is kind of correlated to COM in whole link analysis, while EH (mV) doesn't
  - VEC: $R^2 = 0.68$
  - VEO (EH): $R^2 = 0.01$

- Which is better indicators? VEC vs. EH
  - VEC is a very good indicator for DUT performance
  - EH is NOT strongly correlated to COM, especially for short channels
- Too high of EH threshold risks over-kill good DUT

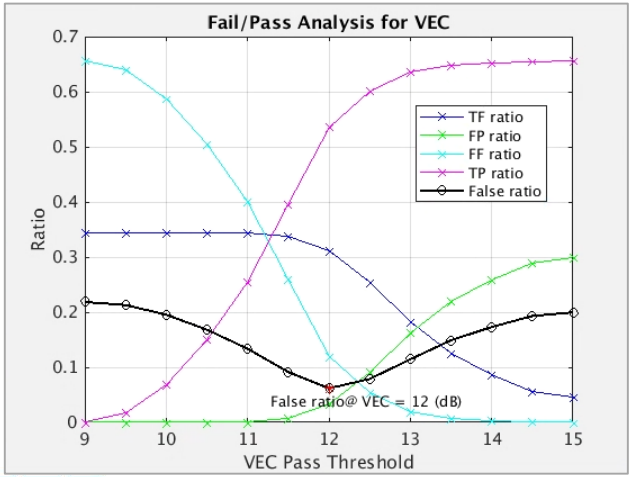




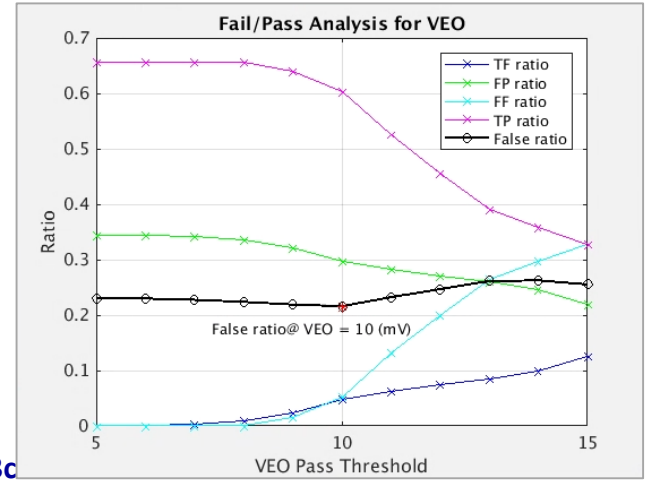
Pass/Fail Analysis – Weighted False Ratio as Criterion

- Definitions of True/False-Pass/Fail

	VEC <= pass threshold (VEO >= pass threshold)	VEC > pass threshold (VEO < pass threshold)
COM >= **3** dB	True-Pass (TP)	False-Fail (FF)
COM < **3** dB	False-Pass (FP)	True-Fail (TF)

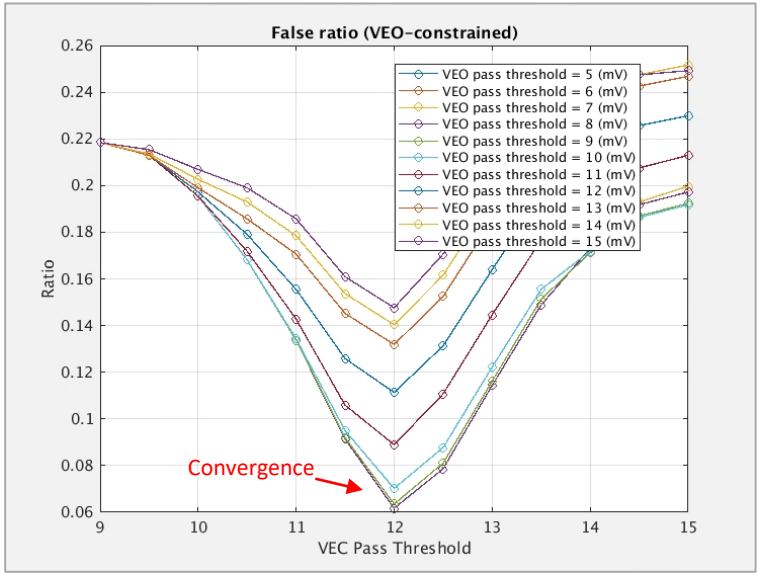


- T_O = 0 mUI for COM
  - Take COM >= **3** dB as pass indicator
- Find VEC & EH thresholds to minimize Weighted False ratio = **(2*FP + FF)/3** ratios
  - VEC = 12 dB with **6.17**% Weighted False ratio
  - EH = 8 mV with **21.60**% Weighted False ratio → quite high, not a good indicator for performance
  - Next: Combine two of them



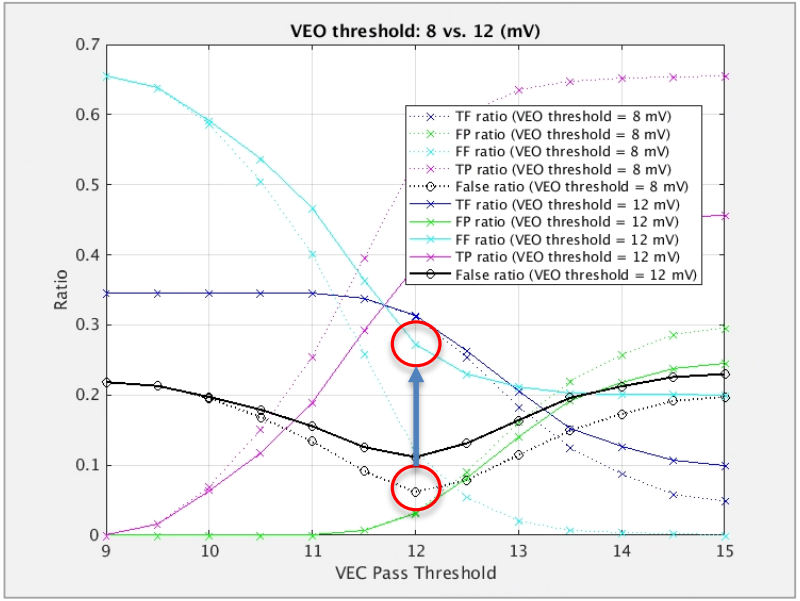
Joint Correlation of VEC/VEO

- VEO-constrained VEC is adopted to conjunctively combine separate pass/fail decisions
  - The procedure adopted in D1p4
  - Filtering samples that didn't meet VEO requirement → [5:15] mV
- Optimal false ratio converges at (with False ratio = 15.25%)
  - VEC pass threshold = 12 dB
  - VEO pass threshold = 8 mV
- Q: is EH (min) = 8 mV too small the value?



Increasing EH (min) doesn't Help, but Hurt

- T_O = 0 mUI for COM
  - Take COM >= **3** dB as pass indicator
- Increasing EH (min) from 8 mV to 12 mV, for example
  - Actually over-kill good DUT (~15% False-Fail ratio increase)
  - No benefits to drop false-passed bad DUT (nearly the same False-Pass ratio)
- The major indicator shall be VEC (max) & keep EH (min) low enough to avoid over-kill good Host DUT



Summary & Proposals

- New TP1a test method impacts VEC & EH & we need new thresholds in D1p5 to reflect that
  - Impact to VEC & EH = +3.24 dB & -7.32 mV
- Based on COM vs. VEC/EH correlation to derive the following new thresholds for D1p5

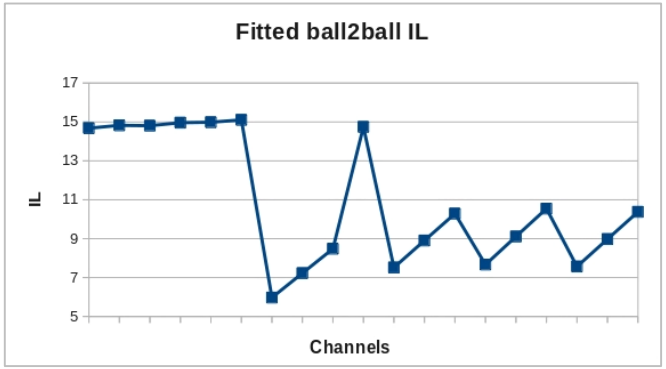
Spec	D1p4	D1p5
VEC	9 dB	12 dB
EH	15 mV	8 mV

Thank You

C2M Host-to-Module Channels for Analysis

- Short Channel
- Long Channel

Contribution	Zip files	Channel	SxP Files
lim_3ck_01a_0319	lim_3ck_01_0319_c2m.zip	Tx7_L10	112G_16dB_(QSFPDD+module card)_TX7_L10
		Tx7_L23	112G_16dB_(QSFPDD+module card)_TX7_L23
		Tx3_L10	112G_16dB_(QSFPDD+module card)_TX3_L10
		Tx3_L23	112G_16dB_(QSFPDD+module card)_TX3_L23
		Tx7_Asic	112G_16dB_(QSFPDD+module card)_TX7_Asic
		Tx3_Asic	112G_16dB_(QSFPDD+module card)_TX3_Asic
lim_3ck_adhoc_01_	073119 lim_3ck_adhoc_02_073119.zip	Ch5a_2"	Channel5a_Smaller_Pad_2inch_trace
		Ch5b_3"	Channel5b_Smaller_Pad_3inch_trace
		Ch5c_4"	Channel5c_Smaller_Pad_4inch_trace
		Ch5d_9"	Channel5d_Smaller_Pad_9inch_trace
akinwale_3ck_adhoc_01a_08282019	akinwale_3ck_C2M_channels_TP0a_100ohms_08222019.zip	2''100Ohm	C2M_2p0in_100Ohm_thru1.s4p
		3''100Ohm	C2M_3p0in_100Ohm_thru1.s4p
		4''100Ohm	C2M_4p0in_100Ohm_thru1.s4p
	akinwale_3ck_C2M_channels_TP0a_85ohms_08222019.zip	2''85Ohm	C2M_2p0in_85Ohm_thru1.s4p
		3''85Ohm	C2M_3p0in_85Ohm_thru1.s4p
		4''85Ohm	C2M_4p0in_85Ohm_thru1.s4p
	akinwale_3ck_C2M_channels_TP0a_93Ohms_08222019.zip	2''93Ohm	C2M_2p0in_93Ohm_thru1.s4p
		3''93Ohm	C2M_3p0in_93Ohm_thru1.s4p
		4''93Ohm	C2M_4p0in_93Ohm_thru1.s4p



COM Settings – Whole Link (for COM Value)

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 0.85e-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 16 ; 1 8 1 8]	mm	[test cases]	
z_p (NEXT)	[2 8 ; 0 0]	mm	[test cases]	
z_p (FEXT)	[12 16 ; 1 8 1 8]	mm	[test cases]	
z_p (RX)	[2 8 ; 0 0]	mm	[test cases]	
C_p	[0.87e-4 0.65e-4]	nF	[TX RX]	
R_0	50	Ohm		
R_d	[50 50]	Ohm	[TX RX]	
A_v	0.415	V	vp/vf=.694	
A_fe	0.415	V	vp/vf=.694	
A_ne	0.608	V		
L	4			
M	32	Samp/UI		
samples_for_C2M	100	Samp/UI		
T_O	50	mUI		
AC_CM_RMS	0	V	[test cases]	[0.0235 0.0256]
filter and Eq				
f_r	0.75	*fb		
c(0)	0.54		min	
c(-1)	[-0.2:0.02:0]		[min:step:max]	
c(-2)	[0:0.02:0.1]		[min:step:max]	
c(-3)	[0]		[min:step:max]	
c(1)	[-0.1:0.02:0]		[min:step:max]	
N_b	4	UI		
b_max(1)	0.4		As/dffe1	
b_max(2..N_b)	[0.15 **0.10** 0.1]		As/dfe2..N_b	
b_min(1)	0.1		As/dffe1	
b_min(2..N_b)	[-0.15 **- 0.05** - 0.05]		As/dfe2..N_b	
g_DC	[-13:1:0]	dB	[min:step:max]	
f_z	12.58	GHz		
f_p1	20	GHz		
f_p2	28	GHz		
g_DC_HP	[-3:0.5:0]		[min:step:max]	
f_HP_PZ	1.328125	GHz		
G_Qual	[-2 -9 ;-2 -12; -4 -12;-6 -13]	dB	ranges	
G2_Qual	[0 -1 -2 -3]	dB	ranges	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	0	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\100GEL_C2M_host_{date	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M_eval_	
COM_CONTRIBUTION	0	logical
Local Search	2	
Operational		
VEC Pass threshold	9	db
EH_min	15	mV
ERL Pass threshold	7.3	dB
DER_0	0.00001	
T_r	0.0075	ns
FORCE_TR	1	5
PMD_type	C2M	
BREAD_CRUMBS	0	logical
SAVE_CONFIG2MAT	1	logical
PLOT_CM	0	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	800	
beta_x	0	
rho_x	0.618	
fixture delay time	[0 0.2e-9]	[port1 port2]
TDR_W_TXPKG	1	
N_bx	0	UI
Tukey_Window	1	
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	4.10E-08	V^2/GHz
SNR_TX	32.5	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
ICN & FOM_ILD parameters		
f_v	0.594	*Fb
f_f	0.594	GHz f_r specified in first column
f_n	0.594	GHz
f_2	40	GHz
A_ft	0.600	V
A_nt	0.600	V

new
upodated for D1.4

Floating Tap Control			
N_bg	0	0 1 2 or 3 groups	
N_bf	3	taps per group	
N_f	40	span for floating taps	
bmaxg	0.2	FE value for floating taps	
for TP4-->	[1.2e-4 0]	nF	[TX RX]
	[0.12 0]	nH	[TX RX]
	[0.3e-4 0]	nF	[TX RX]
	[1 2 3]		[test cases to run]
	[2 7 8]	mm	[test cases]
	[0 0 0]	mm	[test cases]
	[2 7 8]	mm	[test cases]
	[0 0 0]	mm	[test cases]
	[0 0.87e-4]	nF	[TX RX]

Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	[0 3.8206e-04 9.5909e-05]	
board_tl_tau	0.00579	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	407	mm
z_bp (NEXT)	407	mm
z_bp (FEXT)	407	mm
z_bp (RX)	407	mm
C_0	0	nF
C_1	0	nF
Include PCB	0	logical

COM Settings – TP1a

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 0]	nF	[TX RX]	
L_s	[0.12 0]	nH	[TX RX]	
C_b	[0.3e-4 0]	nF	[TX RX]	
z_p select	[1 2]		[test cases to run]	
z_p (TX)	[12 16; 18 18]	mm	[test cases]	
z_p (NEXT)	[0 0 ; 0 0]	mm	[test cases]	
z_p (FEXT)	[12 16; 18 18]	mm	[test cases]	
z_p (RX)	[0 0 ; 0 0]	mm	[test cases]	
C_p	[0.87e-4 0]	nF	[TX RX]	
R_0	50	Ohm		
R_d	[50 50]	Ohm	[TX RX]	
A_v	0.415	V	vp/vf=.694	
A_fe	0.415	V	vp/vf=.694	
A_ne	0.608	V		
L	4			
M	32	Samp/UI		
samples_for_C2M	100	Samp/UI		
T_O	50	mUI		
AC_CM_RMS	0	V	[test cases]	[0.0235 0.0256]
filter and Eq				
f_r	0.75	*fb		
c(0)	0.54		min	
c(-1)	[-0.2:0.02:0]		[min:step:max]	
c(-2)	[0:0.02:0.1]		[min:step:max]	
c(-3)	[0]		[min:step:max]	
c(1)	[-0.1:0.02:0]		[min:step:max]	
N_b	4	UI		
b_max(1)	0.4		As/dffe1	
b_max(2..N_b)	[0.15 **0.10** 0.1]		As/dfe2..N_b	
b_min(1)	0.1		As/dffe1	
b_min(2..N_b)	[-0.15 – **0.05** – 0.05]		As/dfe2..N_b	
g_DC	[-13:1:-0]	dB	[min:step:max]	
f_z	12.58	GHz		
f_p1	20	GHz		
f_p2	28	GHz		
g_DC_HP	[-3:0.5:0]		[min:step:max]	
f_HP_PZ	1.328125	GHz		
G_Qual	[-2-9 ;-2-12; -4-12; -6-13]	dB	ranges	
G2_Qual	[0 -1 -2 -3]	dB	ranges	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	0	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\100GEL_C2M_host_{date	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M_eval_	
COM_CONTRIBUTIOI	0	logical
Local Search	2	
Operational		
VEC Pass threshold	9	db
EH_min	15	mV
ERL Pass threshold	7.3	dB
DER_0	0.00001	
T_r	0.0075	ns
FORCE_TR	1	5
PMD_type	C2M	
BREAD_CRUMBS	0	logical
SAVE_CONFIG2MAT	1	logical
PLOT_CM	0	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	800	
beta_x	0	
rho_x	0.618	
fixture delay time	[0 0.2e-9]	[port1 port2]
TDR_W_TXPKG	1	
N_bx	0	UI
Tukey_Window	1	
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	4.10E-08	V^2/GHz
SNR_TX	32.5	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
ICN & ROM_ILD parameters		
f_v	0.594	*Fb
f_f	0.594	GHz f_r specified in first column
f_n	0.594	GHz
f_2	40	GHz
A_ft	0.600	V
A_nt	0.600	V
new		
upodated for D1.4		

Floating Tap Control			
N_bg	0	0:12 or 3 groups	
N_bf	3	taps per group	
N_f	40	span for floating taps	
bmaxg	0.2	FE value for floating taps	
for TP4-->	[1.2e-4 0]	nF	[TX RX]
	[0.12 0]	nH	[TX RX]
	[0.3e-4 0]	nF	[TX RX]
	[1 2 3]		[test cases to run]
	[2 7 8]	mm	[test cases]
	[0 0 0]	mm	[test cases]
	[2 7 8]	mm	[test cases]
	[0 0 0]	mm	[test cases]
	[0 0.87e-4]	nF	[TX RX]

Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	[0 3.8206e-04 9.5909e-05]	
board_tl_tau	0.00579	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	407	mm
z_bp (NEXT)	407	mm
z_bp (FEXT)	407	mm
z_bp (RX)	407	mm
C_0	0	nF
C_1	0	nF
Include PCB	0	logical