What’s the Reasonable Transition Time?

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For IEEE 802.3ck Ad-Hoc

Outlines

- Background
- Channel and Analysis
- Transition Time Analysis – Sweeping TX FIR
- Summary

Background

- In wu_3ck_adhoc_02_010621, the transition time at TP1a had been observed,
  - They are in the range of 15 ~ 22 ps
  - Those values are much larger than Transition time (min.) at TP1a, which is 7.5 ps in IEEE 802.3ck D1p4
- Exploring what's the possible minimum transition time at TP1a – by simulation with COM device/PKG model
  - By sweeping TX FIR settings in valid range

Channel and Analysis

- Channel
  - TP1a analysis for 2 channels in nineteen IEEE C2M host-to-module channels
    - Short channel (#1) = Ch5a_2" of Jane Lim at 073119
      - Zp = 12 mm (min.)
    - Long channel (#2) = Tx3_Asic of lim_3ck_01_0319_c2m
      - Zp = 30 mm (max.)
- COM parameter settings [details in appendix]
  - COM 3.1
  - TP1a: TX Device/PKG + H2M Channels
- Analysis
  - Sweep TX FIR C1 & Cm1 to increase TX FIR Peaking in dB
    - From 3.4 dB to 18.4 dB peaking gain at Nyquist by TX FIR
  - Calculate 20% ~ 80% transition time (rising & falling times) at TP1a
    - Based on 802.3ck D1p4 & Annex 120E

Tested Channel Characteristics

- Opt. TX FIR
  - selected during TP1a EH/VEC calculation
- TX FIR peaking gain (dB)
  - Peaking gain at Nyquist comparing to DC, 20*log10((-Cm3+Cm2-Cm1+C0-C1)/(Cm3+Cm2+Cm1+C0+C1)) in dB
  - Opt. TX FIR show only 3 ~ 4 dB peaking gain, no matter short or long channels
  - It relies more on RX CTLE & DFE for ISI equalization to avoid swing reduction by TX FIR peaking

Channel	Short (Ch5a_2"), #1	Long (Tx3_Asic), #2
TX package length (Zp)	12 mm	30 mm
Fited IL (Channel only)	5.97 dB	15.10 dB
Fitted IL (TX_LPF + PKG + CH)	11.29 dB	22.45 dB
Opt. TX FIR, [Cm3, Cm2, Cm1, C0, C1]	[0, 0.02, -0.16, 0.82, 0]	[0, 0.02, -0.16, 0.8, -0.02]
TX FIR Peaking (dB)	3.35 dB	3.88 dB

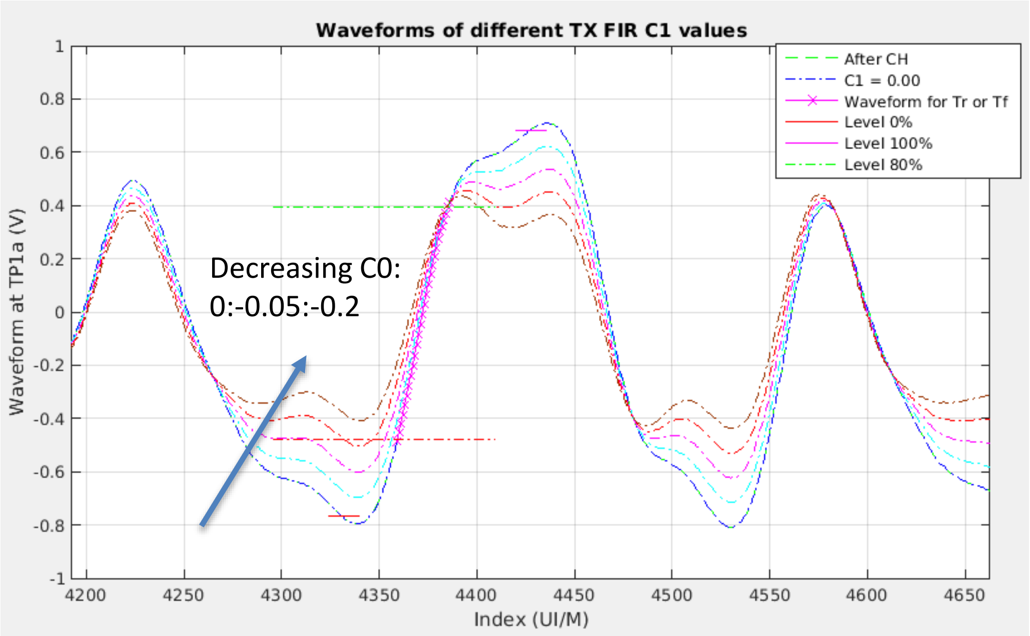
Sweeping TX FIR – C1, followed by Cm1

- In order to have wide range of TX FIR sweeping,
  - Keep Cm3, Cm2, Cm1, & C0 as same as "Opt. TX FIR" for that channel
  - Decrease C1 from 0 to -0.2
  - Kept C1 = -0.2
  - Decrease Cm1 from its original value to have C0 achieves 0.54 (min.)
- A wide range of TX FIR peaking (dB)
  - From 3 to 18 dB
  - To observe the transition time

Cm3	Cm2	Cm1	C0	C1	TX FIR Peaking (dB)
0	0.02	-0.16	0.82	0	3.35
0	0.02	-0.16	0.77	-0.05	4.73
0	0.02	-0.16	0.72	-0.1	6.38
0	0.02	-0.16	0.67	-0.15	8.40
0	0.02	-0.16	0.62	-0.2	11.06
0	0.02	-0.18	0.6	-0.2	12.40
0	0.02	-0.2	0.58	-0.2	13.98
0	0.02	-0.22	0.56	-0.2	15.92
0	0.02	-0.24	0.54	-0.2	18.42

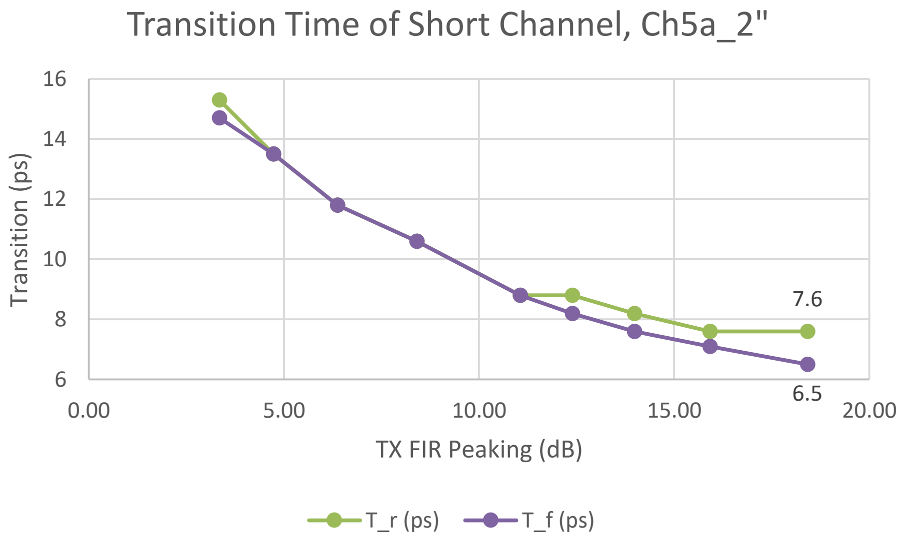
Sweeping TX FIR – Transition Time Analysis

- Channel: Ch5a_2'' (Jane Lim at 073119) – short one
- Set differential peak-to-peak output voltage at TX FIR output = 6000 mV
  - The real silicon may be scaled down to smaller value
  - It's NOT easy to have 870 mV differential peak-to-peak output voltage at TP1a!
- Sweeping TX FIR C1 to observe transition time @ TP1a
  - T_r (ps) decreases when TX FIR peaking increases
  - Details in next slide



Transition Time Analysis Results – Short Channel

- By increasing TX FIR peaking, rising time & falling time can be reduced
  - Up to 6.5 ps for falling time
  - Up to 7.6 ps for rising time
- However, the 18.42 dB TX FIR peaking would NOT be a normal setting for 6 dB IL short channel
  - It means the probability to have this kind of small transition time is low
- Long channel shows larger transition time [Details in appendix]
- Q: Do we still need to set transition time (min.) at TP1a as 7.5 ps?



Related Contributions in 50GAUI-1

- sekel_062817_3cd_adhoc.pdf
  - Argued 12 ps is too fast for test equipment to achieve
  - Target transition time at TP1a had been changed to 19 ps accordingly in 50GAUI, IEEE 802.3bs

Summary

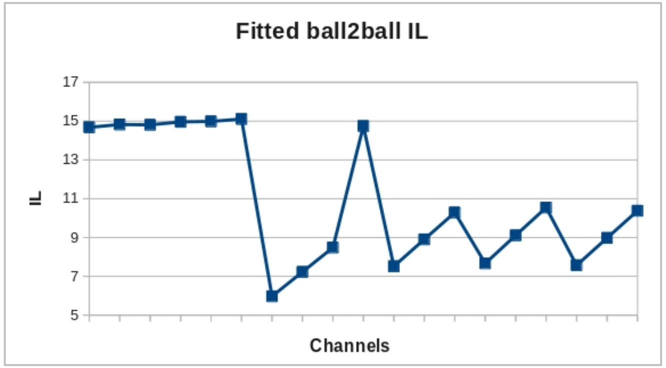
- By sweeping TX FIR peaking
  - 7.5 ps min. transition time could be achieved for short channel
  - However, the chance is low for this condition
- Test equipment may have difficulties in such small transition time
  - Concerns raised in 50G-AUI
- Call to action
  - Think twice whether 7.5 ps is the appropriate min. transition time spec at TP1a
  - More data/analysis may be required to make the decision
  - Maybe we also need to revisit transition time spec at TP4

Thank You

C2M Host-to-Module Channels for Analysis

- Short Channel (red)
- Long Channel (blue)

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	Long
		Tx7_L23	112G_16dB_(QSFPDD+module card)_TX7_L23	Long
		Tx3_L10	112G_16dB_(QSFPDD+module card)_TX3_L10	Long
		Tx3_L23	112G_16dB_(QSFPDD+module card)_TX3_L23	Long
		Tx7_Asic	112G_16dB_(QSFPDD+module card)_TX7_Asic	Long
		Tx3_Asic	112G_16dB_(QSFPDD+module card)_TX3_Asic	Long
lim_3ck_adhoc_01_	073119 lim_3ck_adhoc_02_073119.zip	Ch5a_2"	Channel5a_Smaller_Pad_2inch_trace	Short
		Ch5b_3"	Channel5b_Smaller_Pad_3inch_trace	Short
		Ch5c_4"	Channel5c_Smaller_Pad_4inch_trace	Short
		Ch5d_9"	Channel5d_Smaller_Pad_9inch_trace	Long
akinwale_3ck_adhoc_ 01a_08282019	akinwale_3ck_C2M_channels_TP 0a_100ohms_08222019.zip	2''100Ohm	C2M_2p0in_100Ohm_thru1.s4p	Short
		3''100Ohm	C2M_3p0in_100Ohm_thru1.s4p	Short
		4''100Ohm	C2M_4p0in_100Ohm_thru1.s4p	Short
	akinwale_3ck_C2M_channels_TP 0a_85ohms_08222019.zip	2''85Ohm	C2M_2p0in_85Ohm_thru1.s4p	Short
		3''85Ohm	C2M_3p0in_85Ohm_thru1.s4p	Short
		4''85Ohm	C2M_4p0in_85Ohm_thru1.s4p	Short
	akinwale_3ck_C2M_channels_TP 0a_93Ohms_08222019.zip	2''93Ohm	C2M_2p0in_93Ohm_thru1.s4p	Short
		3''93Ohm	C2M_3p0in_93Ohm_thru1.s4p	Short
		4"93Ohm	C2M_4p0in_93Ohm_thru1.s4p	Short



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; 1.8 1.8]	mm	[test cases]	
z_p (NEXT)	[0 0 ; 0 0]	mm	[test cases]	
z_p (FEXT)	[12 16; 1.8 1.8]	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_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

Transition Time Analysis Results – Long Channel

- By increasing TX FIR peaking, rising time & falling time can be reduced
  - Up to 13.5 ps for falling time
  - Up to 17.1 ps for rising time