COM Sensitivity Analysis of Key Parameters (Update)

Mau-Lin Wu, Pei-Rong Li
MediaTek
IEEE 802.3ck Task Force

Outline

- Background and Motivation
- COM Sensitivity Analysis
  - b_max(1)
  - b_max(2..N_b)
  - Eta_0
  - C_d
- Summary and Proposal

Background and Motivation

- In wu_3ck_adhoc_01_021319.pdf, COM sensitivity to 'N_b', 'b_max(1)', 'b_max(2..N_b)', and 'C_d' had been provided
- Some suggested to check COM sensitivity to b_max by different b_max values
  - Sensitivity to b_max(1) by different b_max(2..N_b)
  - Sensitivity to b_max(2..N_b) by different b_max(1)
- This contribution includes
  - COM sensitivity to b_max(1) & b_max(2..N_b) by different b_max(1) & b_max(2..N_b) settings
  - COM sensitivity to 'Eta_0'
  - COM sensitivity to 'C_d' (with 42 channels)
- Conclusions
  - Interactions between b_max(1) & b_max(2..N_b) observed
  - COM is very sensitive to 'Eta_0'

Baseline COM Parameters

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	[1.1e-4 1.1e-4]	nF	[TX RX]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[12.32; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[12.32; 1.8 1.8]	mm	[test cases]
z_p (FEXT)	[12.32; 1.8 1.8]	mm	[test cases]
z_p (RX)	[12.32; 1.8 1.8]	mm	[test cases]
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.413	V	vp/vf=.694
A_fe	0.413	V	vp/vf=.694
A_ne	0.608	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.54		min
c(-1)	[-0.34:0.02:0]		[min:step:max]
c(-2)	[0:0.02:0.12]		[min:step:max]
c(-3)	[-0.06:0.02:0]		[min:step:max]
c(1)	[-0.1:0.05:0]		[min:step:max]
N_b	24	UI	
b_max(1)	0.85		
b_max(2..N_b)	0.2		
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	21.25	GHz	
f_p1	21.25	GHz	
f_p2	53.125	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	
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		

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	0	logical
CSV_REPORT	1	logical
RESULT_DIR	\results\100GEL_WG_[date]\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	CR_eval_	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	10.5	dB
DER_0	1.00E-04	
T_r	6.16E-03	ns
FORCE_TR	1	logical
Include PCB	0	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	1000	
TDR_Butterworth	1	logical
beta_x	1.70E+09	
rho_x	**0.25**	
fixture delay time	0	enter sec
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	8.20E-09	V^2/GHz
SNR_TX	33	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

Table 92-12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 3.8206e-04 9.5909e-05]*	
board_tl_tau	*5.790E-03*	ns/mm
board_Z_c	90	Ohm
z_bp (TX)	*119*	mm
z_bp (NEXT)	*119*	mm
z_bp (FEXT)	*119*	mm
z_bp (RX)	*119*	mm

Selected 9 KR Channels

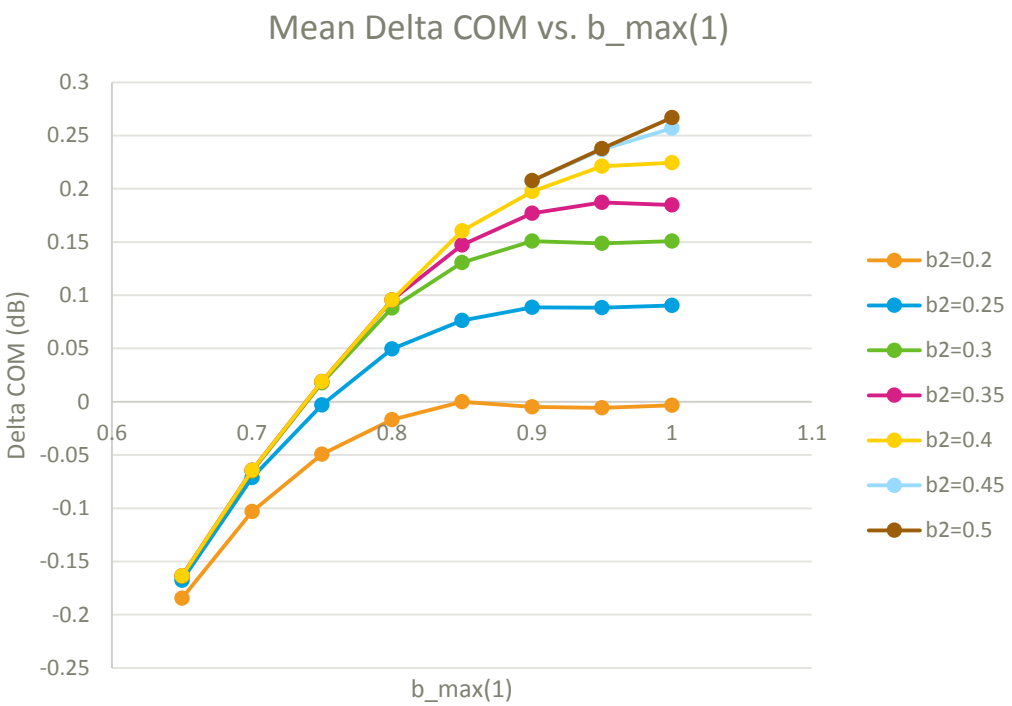
- 9 KR channels were selected as baseline in ‘kochuparambil_3ck_01c_0119.pdf’

Contribution	Channel	CH ID
heck_3ck_01_1118	28dB Cabled Backplane/Cable_BKP_28dB_0p575m_more_isi	1
	16dB Cabled Backplane/Cable_BKP_16dB_0p575m_more_isi	2
mellitz_3ck_adhoc_02_081518	24,28,30dB including BGA Via/CaBP_BGAVia_Opt2_28dB	3
tracy_3ck_01_0119	Traditional Backplane Channels/Std_BP_12inch_Meg7	4
	Orthogonal Backplane Channels/DPO_IL_12dB	5
kareti_3ck_01a_1118	Measured Orthogonal Backplane Channels/OAch4	6
	Measured Orthogonal Backplane Channels/Och4	7
	Measured Cabled Backplane Channels/CAch3_b2	8
	Measured Traditional Backplane Channels/Bch2_a7p5_7	9

COM Sensitivity – b_max

- Simulation conditions
  - Based on COM spread sheet at page 4
  - Including IEEE 42 channels for analysis [Selected 9 KR channels inc.]
  - COM 2.58 with baseline package (C_d = 110 fF)
  - DFE
    - N_b = 24
    - With different 'b_max(1)' & 'b_max(2..N_b)' settings
- Sensitivity analysis
  - Define 'Delta COM(b_1,b_2,CH_i)' = COM(b_1,b_2,CH_i) – COM(0.85,0.2,CH_i)
    - Where b_1 = b_max(1) & b_2 = b_max(2..N_b), & CH_i = the ith channel
  - Analyze COM sensitivity by 'mean of Delta COM' among all channels

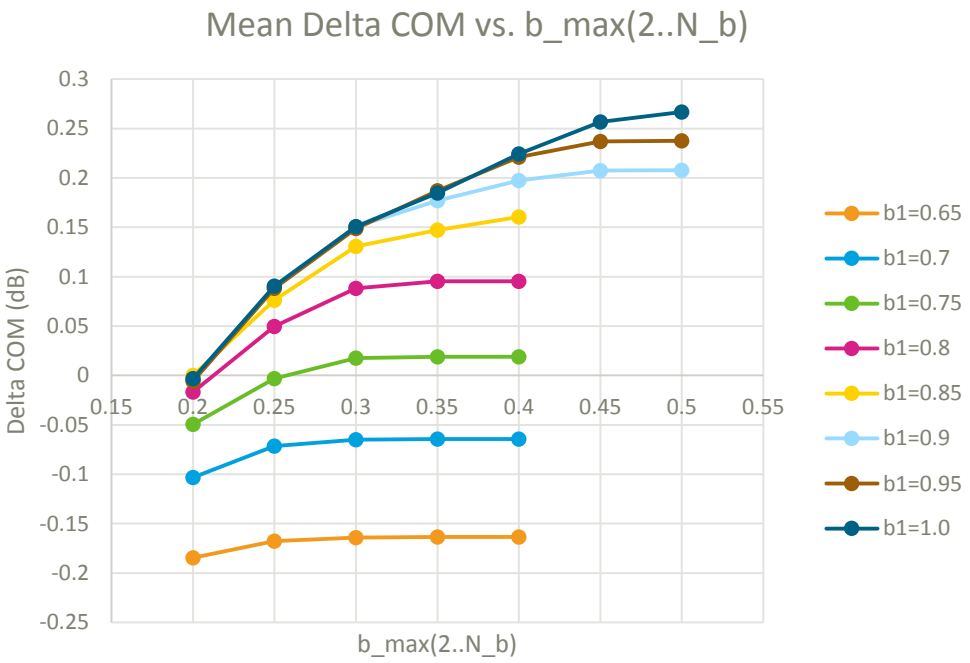
‘b_max(1)’ Results



- For b2<=0.35, COM is NOT sensitive to b1 in the range of b1 = 0.85 to 1.0
  - Within 0.05 dB mean difference
- With larger b2 (>=0.4), larger b1 provides some gains up to 0.1 dB
- Larger b_max(1) raises concerns of error propagation, which is NOT considered in COM model
- Proposal
  - Adopt b_max(1) = **0.85**

@ b_max(2..N_b) = 0.35		COM Sensitivity (dB, mean)	
b_max(1)	b_max(1) Range	0.6~0.85	0.85~1
	Sen. (COM/val)	0.13 dB/0.1	0.02 dB/0.1

‘b_max(2..N_b)’ Results

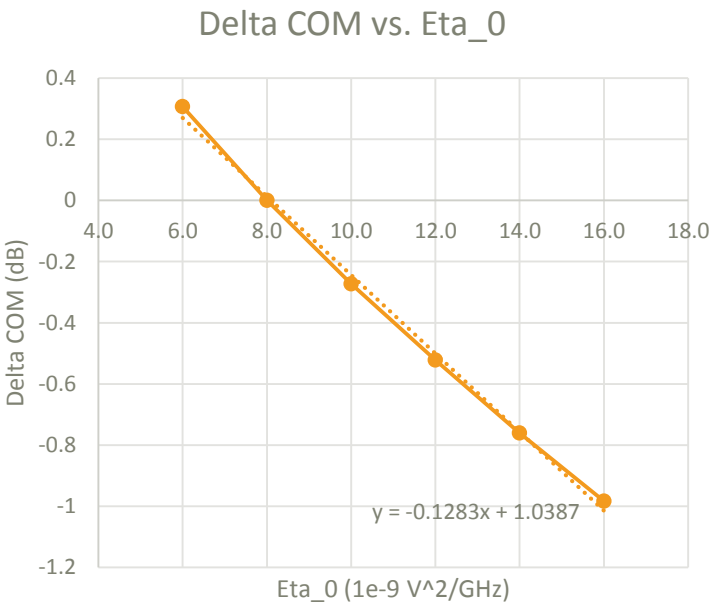


- For b1<=0.9, COM is NOT sensitive to b2 in the range of b2 = 0.35 to 0.5
  - Within 0.05 dB mean difference
- With larger b1 (>=0.95), larger b2 provides some gains up to 0.08 dB
- Proposal
  - Adopt b_max(2..N_b) = **0.35**

@ b_max(1) = 0.9		COM Sensitivity (dB, mean)	
b_max(2..N_b)	b_max(2..N_b) Range	0.2~0.35	0.35~0.5
	Sen. (COM/val)	0.13 dB/0.1	0.02 dB/0.1

COM Sensitivity – 'Eta_0'

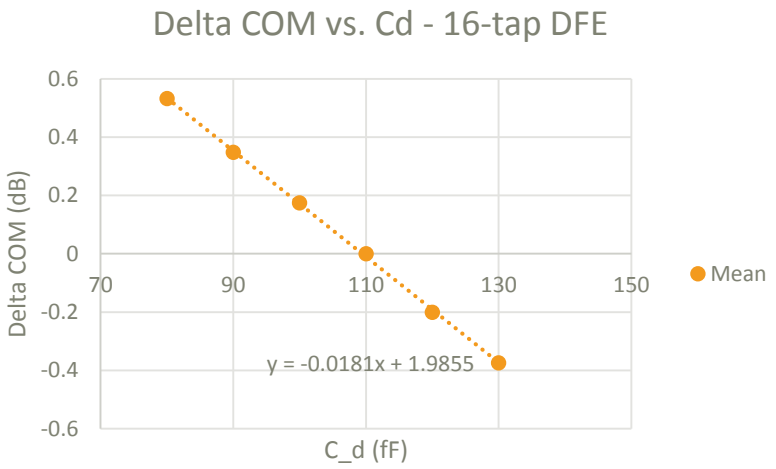
- Including IEEE 42 channels for analysis [Selected 9 KR channels inc.]
- COM 2.58 with baseline package (C_d = 110 fF)
- DFE
  - N_b = 24
  - With different 'Eta_0'
- COM is quite sensitive to 'Eta_0'
  - 0.13 dB loss per extra 1e-9 V^2/GHz Eta_0
- How to decide Eta_0 (noise power density)?
  - We adopted 16.4e-9 @ 50Gbps
  - Background noise on board → independent of BW → 8.2e-9
  - Ref. RX noise → scaled by BW → 16.4e-9
  - How about 50%-50% as **12.3e-9** ?

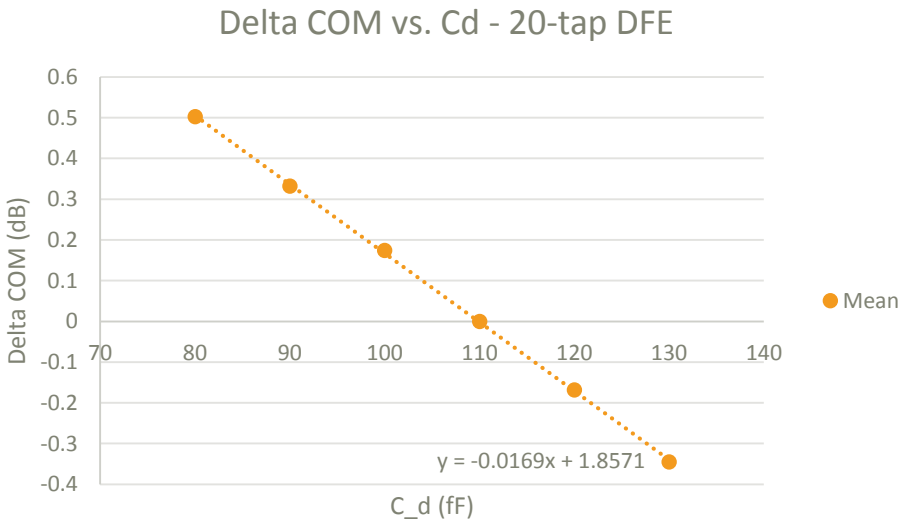


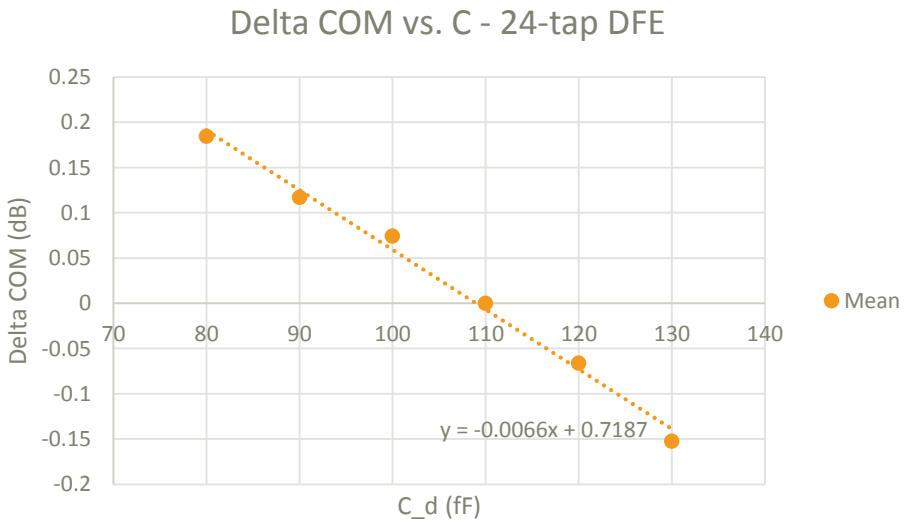
	COM Sensitivity (dB, mean)	
Eta_0		6.0~16.0e-9 V^2/GHz
	Sen. (COM/Eta_0)	0.13 dB/1e-9

COM Sensitivity – 'C_d'

- COM 2p58 – baseline package model (C_d = 110 fF)
- Selected **42 KR channels**
  - Got similar results by 9 selected KR channels
- 16 & 20-tap DFEs
  - Double reflection of package NOT covered by DFE
  - COM sensitivity ~= 0.17~0.18 dB / 10fF
- 24-tap DFE
  - COM sensitivity ~= 0.07 dB / 10fF
- COM is sensitive to 'C_d' if N_b <= 20







COM Sensitivity – Summary

		COM Sensitivity (dB, mean)		
N_b*1	N_b Range	20~22	18~20, 22~24	Others
	Sen. (COM/tap)	0.46 dB/tap	0.10 dB/tap	0.02 dB/tap
b_max(1)	b_max(1) Range	0.6~**0.85**	0.85~1	
	Sen. (COM/val)	0.13 dB/0.1	0.02 dB/0.1	
b_max(2..N_b)	b_max(2..N_b) Range	0.2~**0.35**	0.35~0.5	
	Sen. (COM/val)	0.13 dB/0.1	0.02 dB/0.1	
C_d*1	N_b Range	16	20	24
	Sen. (COM/10fF)	0.18 dB/10fF	0.17 dB/10fF	0.07 dB/10fF
Eta_0		6.0~16.0e-9 V^2/GHz		
	Sen. (COM/Eta_0)	0.13 dB/1e-9		

- Proposals based on COM sensitivity analysis
- N_b = 24
- b_max(1) = 0.85 & b_max(2..N_b) = 0.35
- Eta_0 = 12.3e-9 V^2/GHz

PS: *1. Refer to 'wu_3ck_adhoc_01_021319.pdf'

Summary & Proposal

- Selected 42 KR channels for COM sensitivity analysis
  - Requires DFE taps to cover ‘double-reflection’ from package
  - Sets large b_max values to benefit better COM
  - Sensitive to Eta_0, be cautious to define it
- Proposals based on COM sensitivity analysis
  - N_b = 24
  - b_max(1) = 0.85 & b_max(2..N_b) = 0.35
  - Eta_0 = 12.3e-9 V^2/GHz

everyday genius