C2M VEC with Rx Noise

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Objective

- sun_3ck_01a_0120 proposed to improve TP1a VEC measurement by EVEC or “extra receiver noise”. Results with EVEC and $b_{max}(1) = 0.5$ was discussed.

- This work is to include results of “extra receiver noise”. $b_{max}(1) = 0.5$ and 0.3 are both considered.

Simulation Conditions

- 405 test cases for each condition
  - 27 IEEE802.3ck C2M channels (same as base channel set in sun_3ck_01a_0120)
  - 15 cases of Tx PKG zp ([12:20 22:2:32] mm)
  - 1 case of Rx PKG zp (0mm for TP1a, 6mm for whole link)

- COM parameters (details in back up slides)
  - Same as sun_3ck_02_1119 (slides 19,20) except eta_0 and $b_{max}(1)$
  - COM 2.76

Type		TP1a			Whole Link		
Condition Label		TPx1	TPx5	TPx10	WLx1	WLx5	WLx10
eta_0 (V^2/GHz)		0.82E-8	4.1E-8	8.2E-8	0.82E-8	4.1E-8	8.2E-8
Result Label	VEC	VECx1	VECx5	VECx10			
	EH	EHx1	EHx5	EHx10			
	COM				COMx1	COMx5	COMx10
TX FIR		3 pre, 1 post optimized for each case			Coefficients fixed to the optimization result of TPxN for WLxN		
CTLE		2 zero, 3 poles optimized for each case			2 zero, 3 poles optimized for each case		
DFE		4 tap ($b_{max}(1)$=0.3 or 0.5, $b_{max}([2\text{-}4])$=0.2) optimized for each case			4 tap ($b_{max}(1)$=0.3 or 0.5, $b_{max}([2\text{-}4])$=0.2) optimized for each case		

Short Channel Set

ID	Channel Description	IL (dB)	ERL22 (dB)	ICN (mV)	ILD (dB)
1	lim_3ck_adhoc_01_073119\2inch	5.67	11.41~12.16	3.52	0.16
2	lim_3ck_adhoc_01_073119\3inch	6.94	12.43~13.12	3.05	0.15
3	lim_3ck_adhoc_01_073119\4inch	8.22	13.30~13.81	2.65	0.14
4	lim_3ck_adhoc_01_073119\9inch	14.55	15.97~16.17	1.34	0.13
5	akinwale_3ck_adhoc_01a_08282019\2inch	7.15	13.76~14.63	5.54	0.36
6	akinwale_3ck_adhoc_01a_08282019\3inch	8.37	14.84~15.58	5.24	0.36
7	akinwale_3ck_adhoc_01a_08282019\4inch	9.70	15.70~16.34	5.01	0.36

- Same channels as sun_3ck_02_1119, slide 5.
- Channel 4 may be categorized as a long channel, but remains in this category for the consistency with the previous contributions.

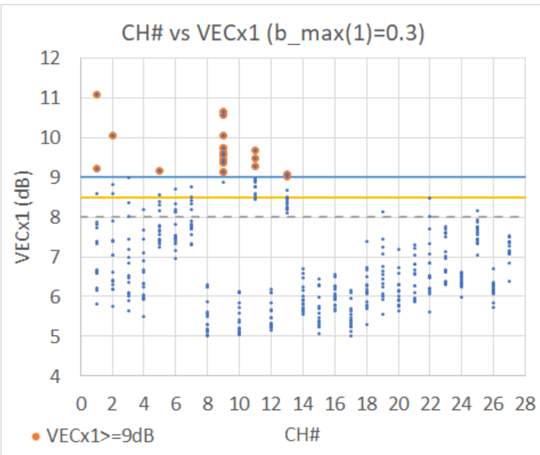
Long Channel Set

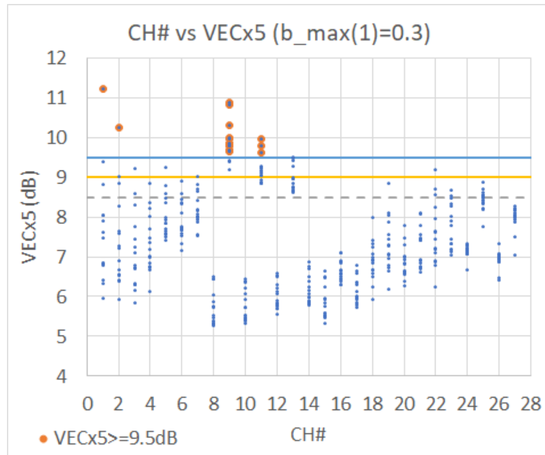
ID	Channel Description	Vote in May	IL (dB)	ERL22 (dB)	ICN (mV)	ILD (dB)
8	mellitz_3ck_01_0518_C2M\9dB	Pass	8.95	15.00~15.79	2.10	0.10
9	mellitz_3ck_01_0518_C2M\10dB	Fail	9.96	11.11~11.51	4.27	0.48
10	mellitz_3ck_01_0518_C2M\11dB	Pass	11.16	15.93~16.35	1.75	0.09
11	mellitz_3ck_01_0518_C2M\12dB	Fail	12.18	12.72~13.07	3.75	0.46
12	mellitz_3ck_01_0518_C2M\13dB	Pass	13.12	16.84~17.12	1.50	0.09
13	mellitz_3ck_01_0518_C2M\14dB	Fail	13.87	14.26~14.52	2.98	0.47
14	tracy_3ck_02a_1119\5inch host\TX5	TBD	7.84	14.47~15.26	1.53	0.12
15	tracy_3ck_02a_1119\5inch host\TX6	TBD	8.54	15.04~15.77	1.90	0.13
16	tracy_3ck_02a_1119\10inch host\TX5	TBD	13.57	16.22~16.48	0.86	0.12
17	tracy_3ck_02a_1119\10inch host\TX6	TBD	14.28	17.13~17.43	1.01	0.14
18	lim_3ck_01_0319_QDD_new_pad\ch1	Pass	14.40	22.03~22.62	0.73	0.20
19	lim_3ck_01_0319_QDD_new_pad\ch2	Pass	14.60	21.28~21.80	0.76	0.19
20	lim_3ck_01_0319_QDD_legacy_pad\ch3	Pass	14.69	17.90~18.23	0.72	0.20
21	llim_3ck_01_0319_QDD_legacy_pad\ch4	Pass	14.84	17.56~17.84	0.81	0.18
22	llim_3ck_01_0319_QDD_new_pad\ch5	TBD	14.77	21.71~22.29	1.34	0.16
23	llim_3ck_01_0319_QDD_legacy_pad\ch6	Pass	15.02	17.82~18.14	1.47	0.17
24	ito_3ck_01_1118\QSFP \bottom normal\	Pass	15.10	11.32~11.42	1.14	0.18
25	ito_3ck_01_1118\QSFP \bottom worst\	TBD	15.58	11.10~11.19	1.09	0.32
26	ito_3ck_01_1118\QSFP \top normal\	Pass	14.53	11.41~11.51	1.19	0.18
27	ito_3ck_01_1118\QSFP \top worst\	TBD	14.49	11.13~11.21	1.14	0.31

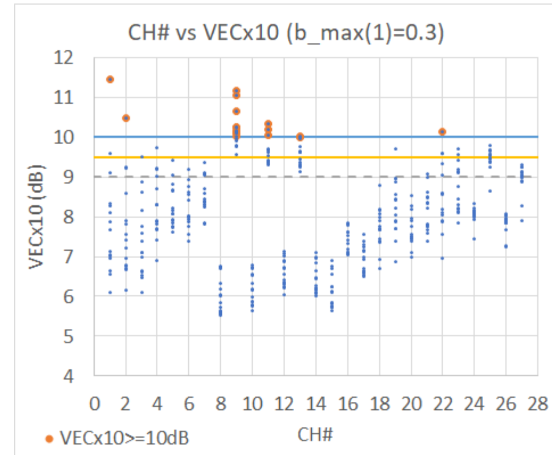
- Same channels as sun_3ck_01a_0120, slide 6.
- Channels 14 thru 17 are updated from sun_3ck_02_1119, slide 4.
- Channels 8,9,14,15 may be categorized as a short channel.

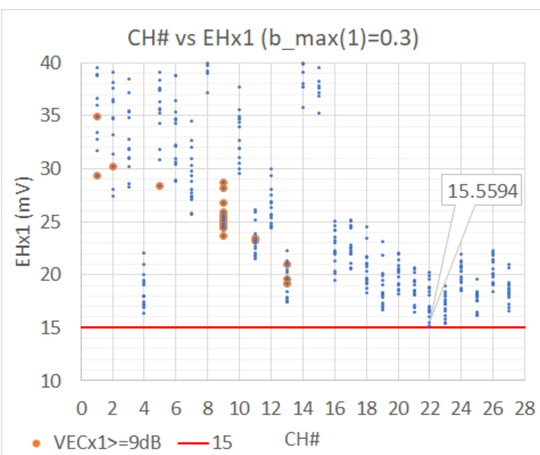
CH# vs VEC and EH at TP1a with $b_{max}(1)=0.3$

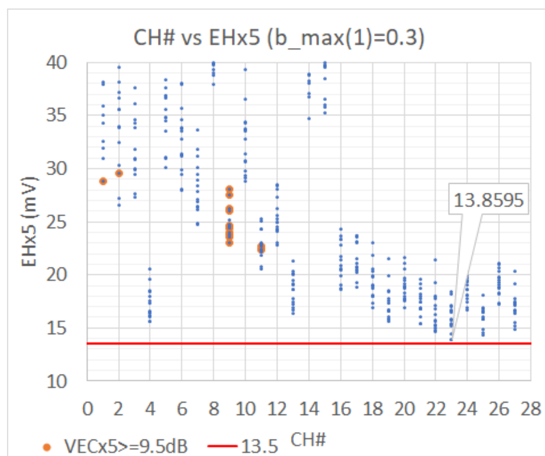
- Figures below show VEC/EH of each channel with different package length.
- Yellow lines in VEC plot are possible thresholds to filter out bad channels. For example, 9 dB VEC threshold for VECx5. Noise penalizes high loss channels more than short channels.
- All EH pass 15mV for EHx1, 13.5mV for EHx5, 12.0mV for EHx10.

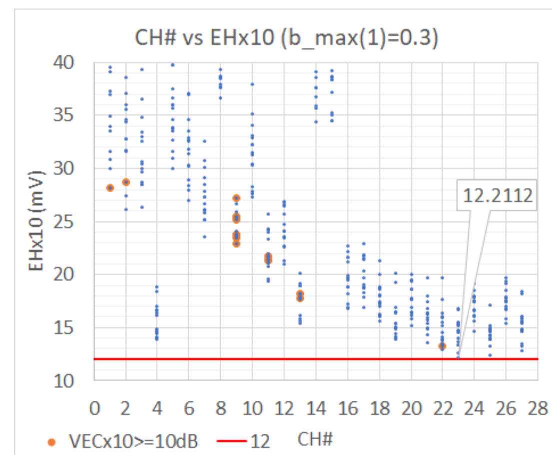






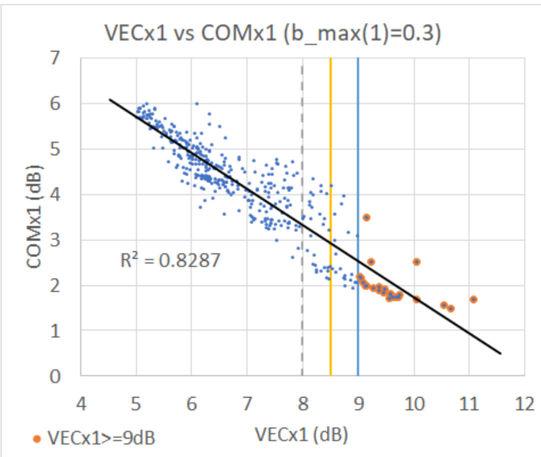


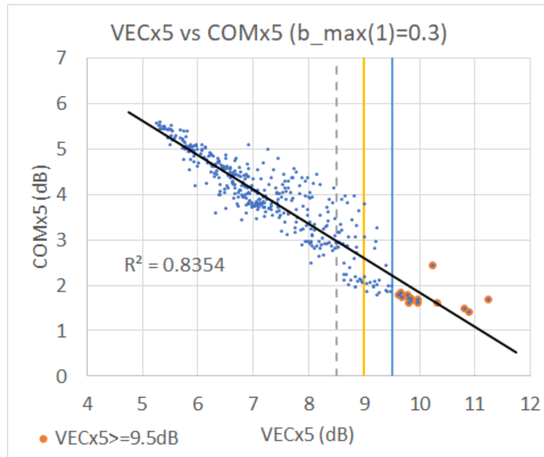


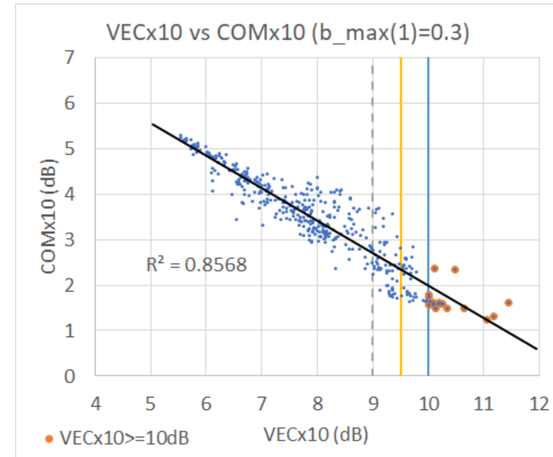


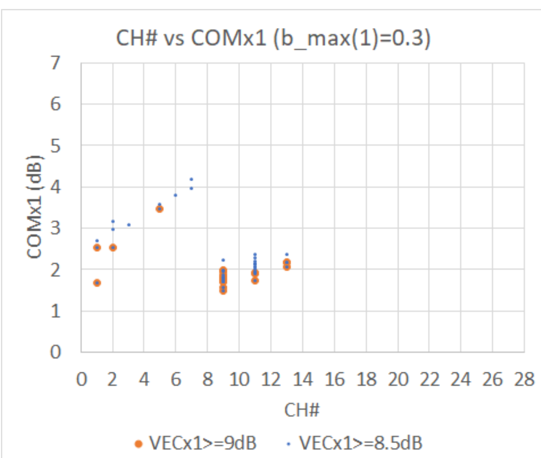
VEC and CH# vs COM with $b_{max}(1)=0.3$

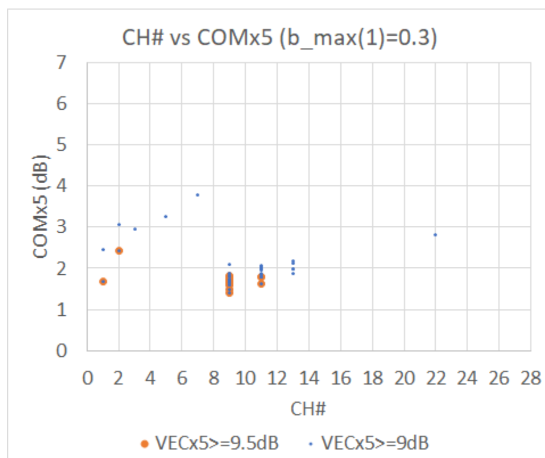
- Top plots show correlation between VEC at TP1a and COM of whole link.
- Bottom plots show CH# vs COM of VEC failing cases for two higher threshold levels (in solid lines).
  - Each line is shifted by 0.5dB from x1 to x5 and from x5 to x10.
  - No dots shown for cases of VEC passing the second threshold level.

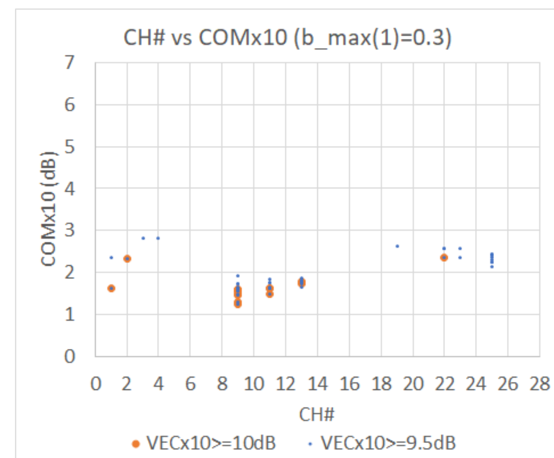






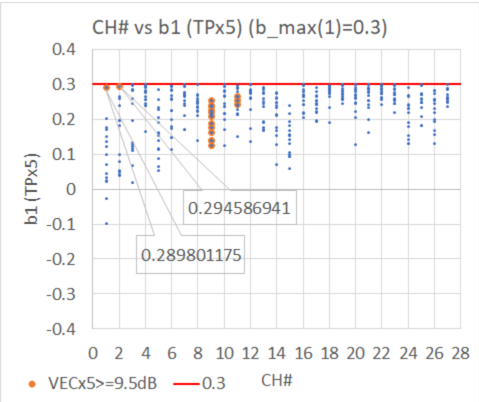


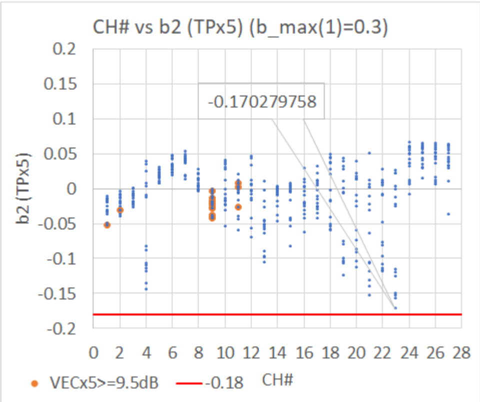


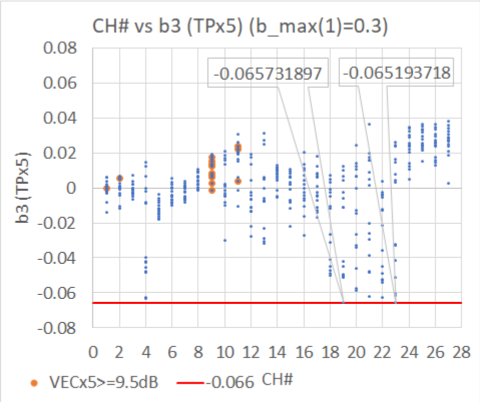


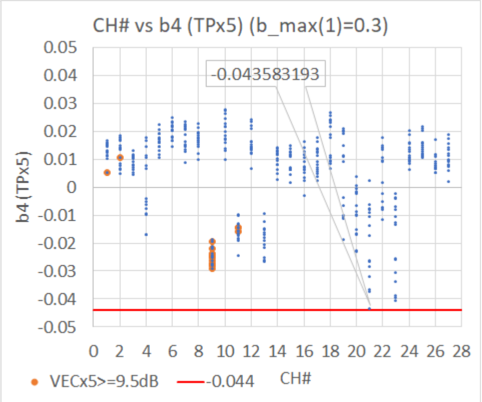
DFE Tap Weight Range

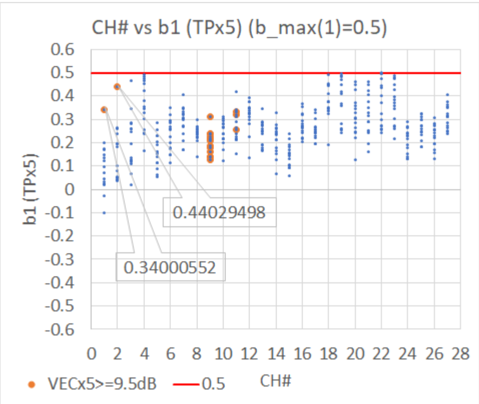
- x5 Rx noise for all plots. Top plots show b[1-4] with $b_{max}(1)=0.3$, and bottom plots with $b_{max}(1)=0.5$.
- Red dots are the cases that fail 9.5dB VEC.
- $b_{max}(2\text{-}4)$ has smaller range if $b_{max}(1)=0.5$.

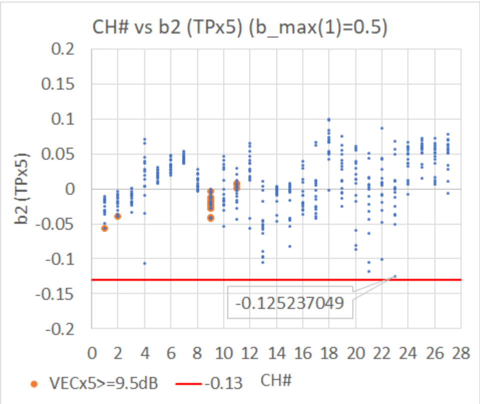


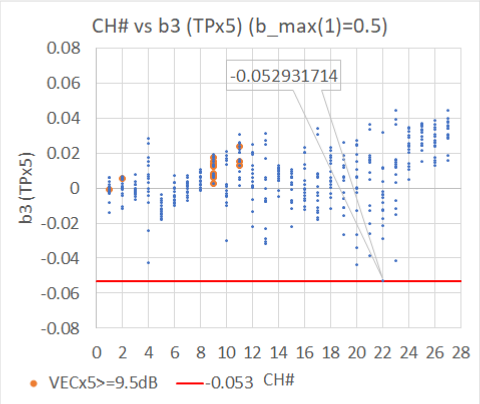


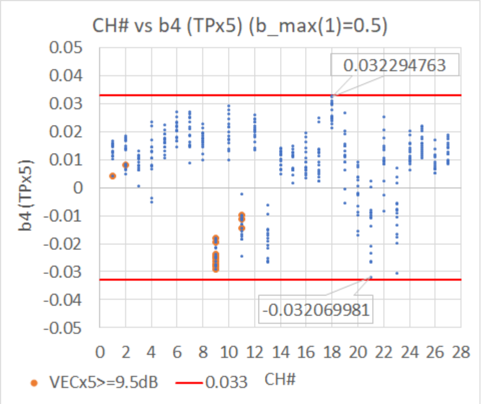






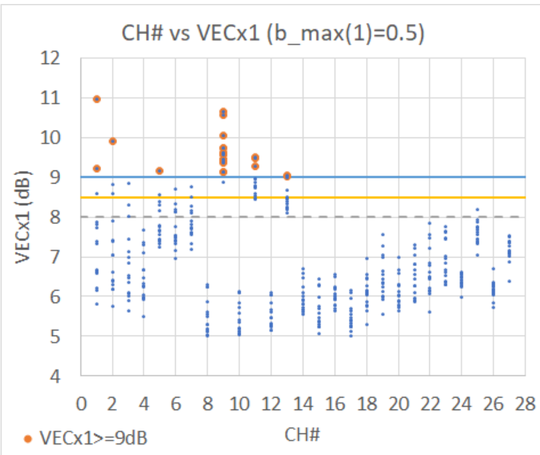


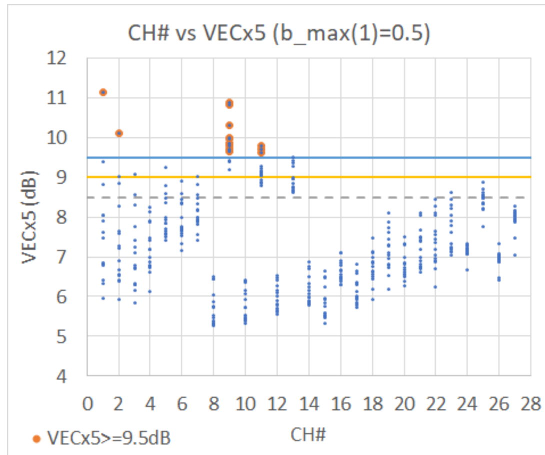


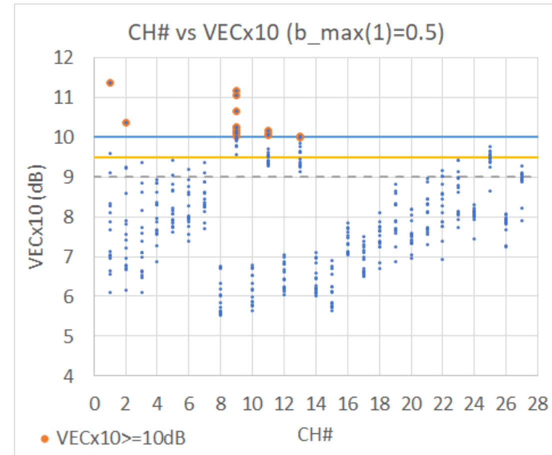


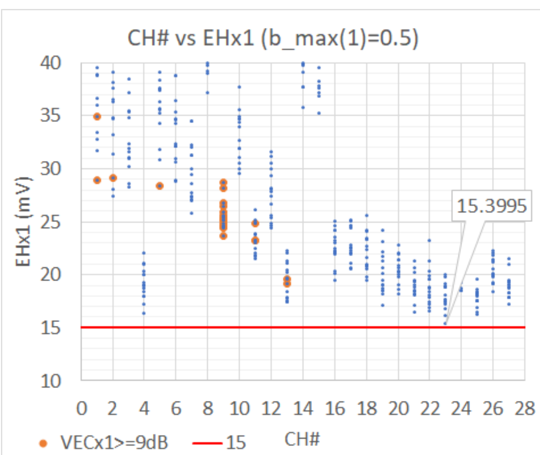
CH# vs VEC and EH at TP1a with $b_{max}(1)=0.5$

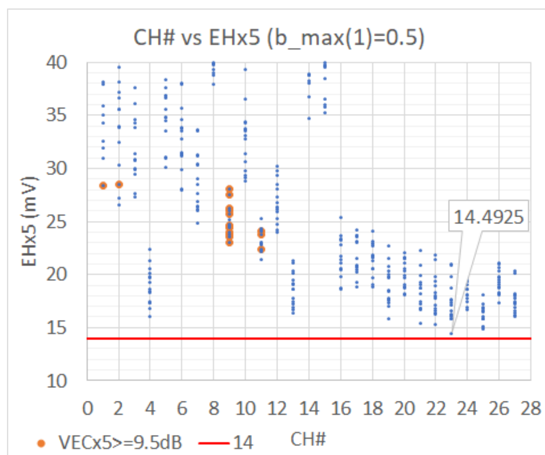
- Compared to $b_{max}(1)=0.3$, VEC is improved for some channels (e.g. CH1,2,19,22,23).
- All EH pass 15mV for EHx1, 14mV for EHx5, and 13mV for EHx10.

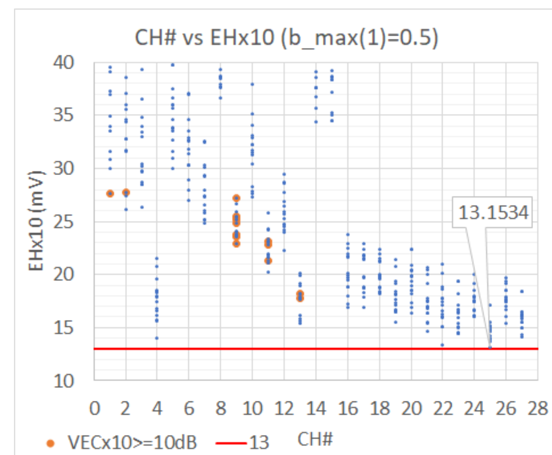






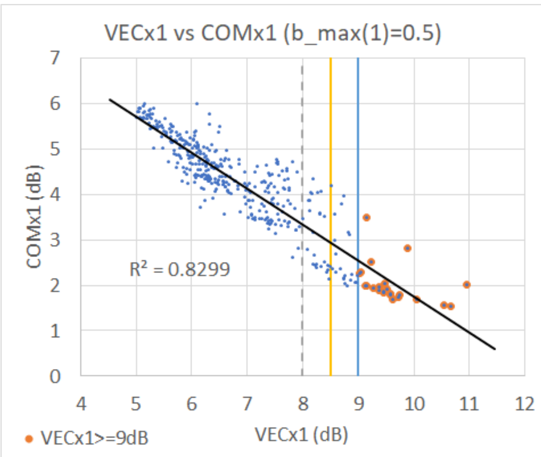


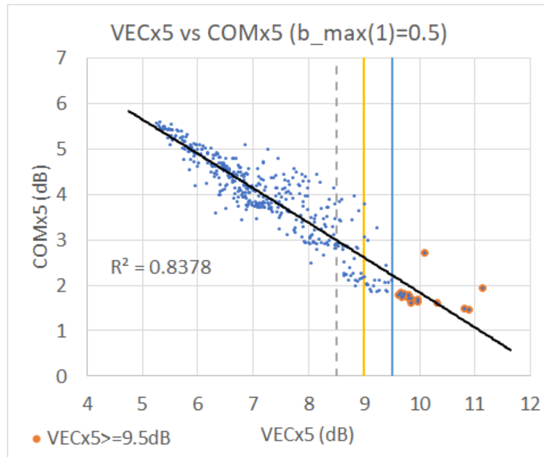


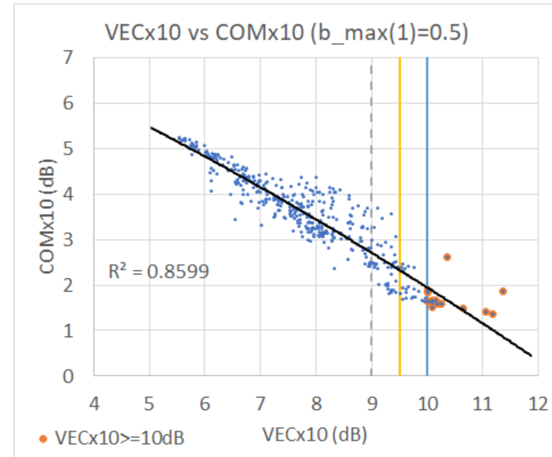


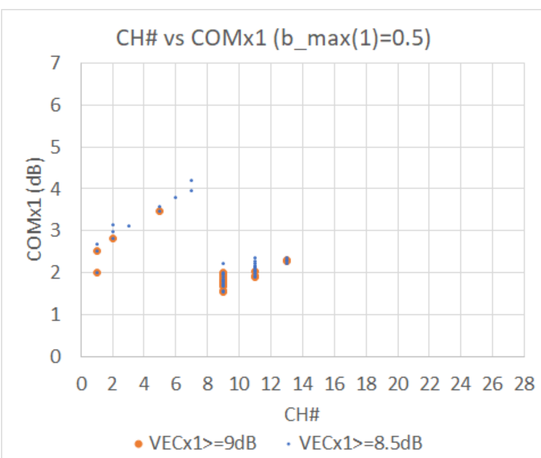
VEC and CH# vs COM with $b_{max}(1)=0.5$

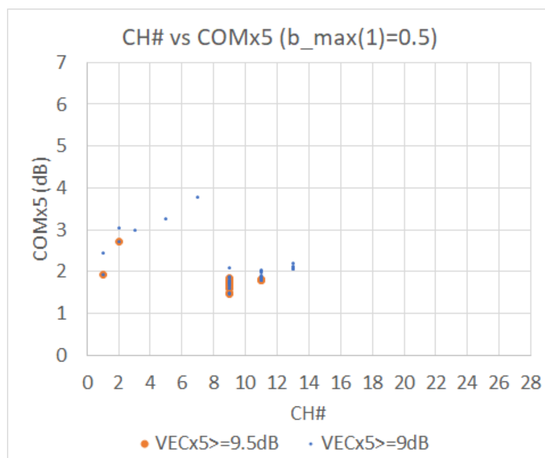
- Compared to $b_{max}(1)=0.3$, COM is improved for some cases including the worst cases of CH1, CH2.

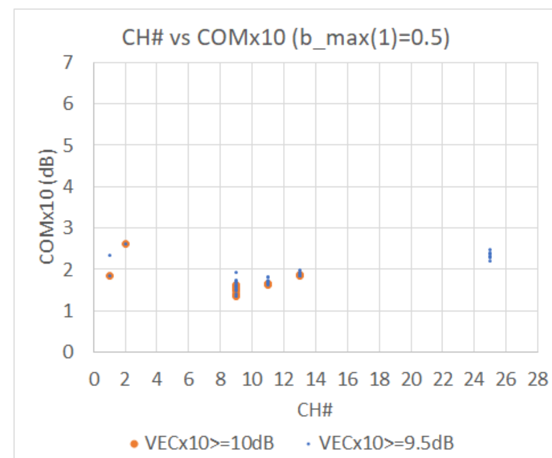








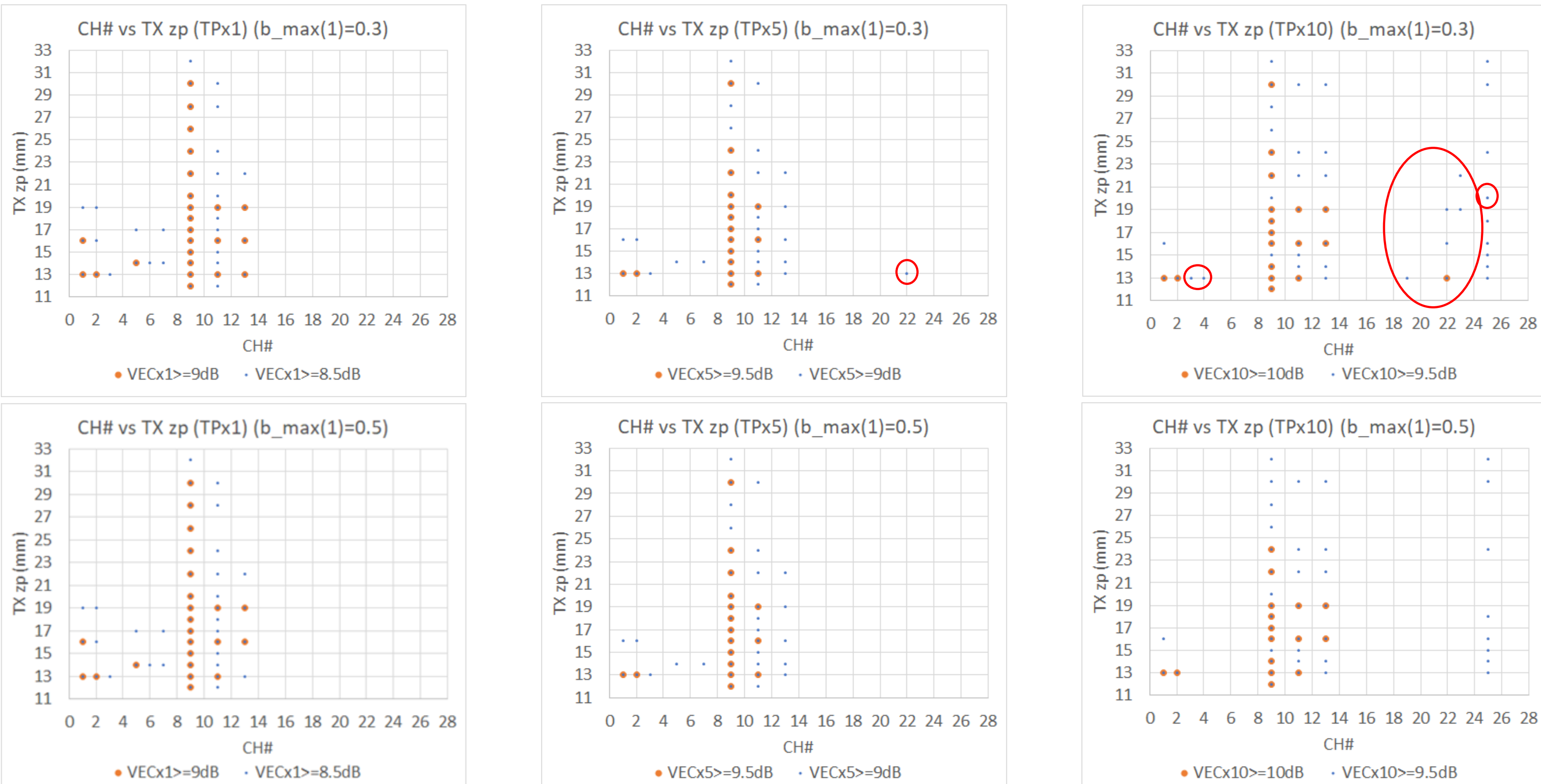




VEC Pass/Fail for CH#×TXzp vs $b_{max}(1)$=0.3 or 0.5

- Plots below show combinations of CH# and TX zp failing VEC at the two thresholds levels.
  - Missing dot means that VEC passes for the second threshold level.
- Some failing cases with $b_{max}(1)$=0.3 pass with $b_{max}(1)$=0.5 (e.g. TPx5:CH22, TPx10:CH3/4/19/22/23)

○: difference between $b_{max}(1)$=0.3 and 0.5



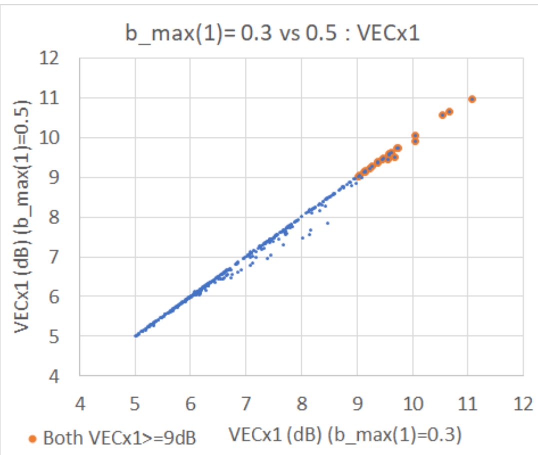
VEC in Marginal Conditions except CH9,11,13

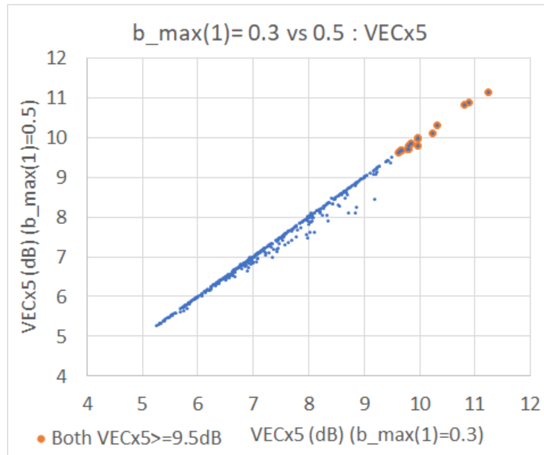
- Red value: VEC fails the first threshold level, Magenta value: VEC fails the second threshold level, Green value: VEC passes the second threshold level.

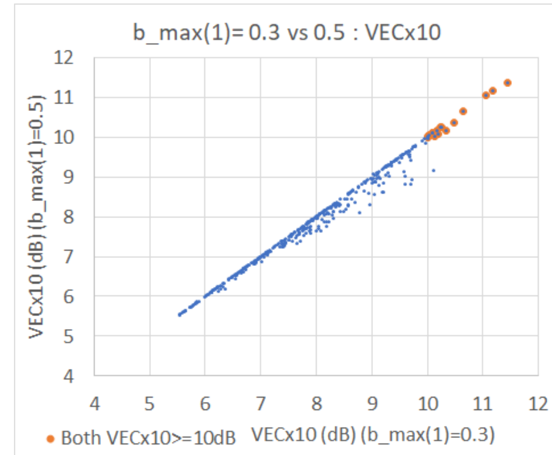
CH	TX zp	$b_{max}(1)=0.3$			$b_{max}(1)=0.5$		
		VECx1	VECx5	VECx10	VECx1	VECx5	VECx10
1	13	11.0672	11.2343	11.4416	10.9618	11.1376	11.3547
	16	9.2289	9.3894	9.5942	9.2289	9.3894	9.5942
	19	8.5964	8.8181	9.0919	8.5964	8.8181	9.0919
2	13	10.055	10.2412	10.4736	9.8904	10.0951	10.3486
	16	8.8186	9.0089	9.2529	8.8186	9.0089	9.2529
	19	8.5825	8.8593	9.2047	8.5825	8.8593	9.2047
3	13	8.9886	9.2157	9.5035	8.8435	9.0704	9.3579
4	13	8.1743	8.8597	9.7263	7.6789	8.2316	8.9258
5	14	9.1572	9.2333	9.4306	9.1572	9.2333	9.4306
	17	8.5723	8.7888	9.0431	8.5723	8.7888	9.0431
6	14	8.6892	8.9075	9.1852	8.6892	8.9075	9.1852
7	14	8.7479	9.0155	9.3519	8.7479	9.0155	9.3519
	17	8.5060	8.8280	9.1088	8.5060	8.8280	9.1088
19	13	8.1406	8.8365	9.7032	7.5478	8.1025	8.8073
22	13	8.4679	9.1902	10.1211	7.8561	8.4396	9.1739
	16	8.0224	8.7137	9.5987	7.4710	8.0953	8.8210
	19	7.7091	8.5471	9.5943	7.5496	8.2615	9.0086
23	19	7.7091	8.5428	9.5739	7.6464	8.2883	9.1181
	22	7.7535	8.6687	9.7005	7.7535	8.6168	9.4289
25	13	8.1516	8.8688	9.7783	8.1831	8.8728	9.7553
	14	7.8822	8.6202	9.5630	7.8822	8.6202	9.5630
	15	7.9445	8.6958	9.6574	7.9445	8.6958	9.6574
	16	7.7460	8.5431	9.5539	7.7460	8.5431	9.5539
	18	7.7396	8.5363	9.5429	7.7396	8.5363	9.5429
	20	7.6780	8.5530	9.5478	7.6780	8.5530	9.4786
	24	7.6189	8.4725	9.5545	7.6189	8.4725	9.5545
	30	7.4362	8.4072	9.6725	7.4362	8.4635	9.6373
	32	7.4218	8.4261	9.6871	7.3850	8.3406	9.5585

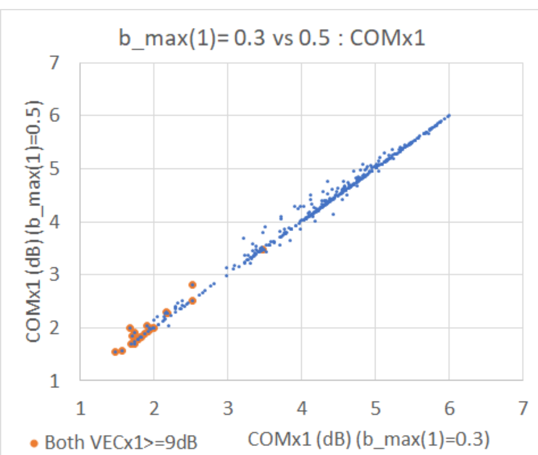
$b_{max}(1)=0.3$ vs $b_{max}(1)=0.5$: VEC and COM

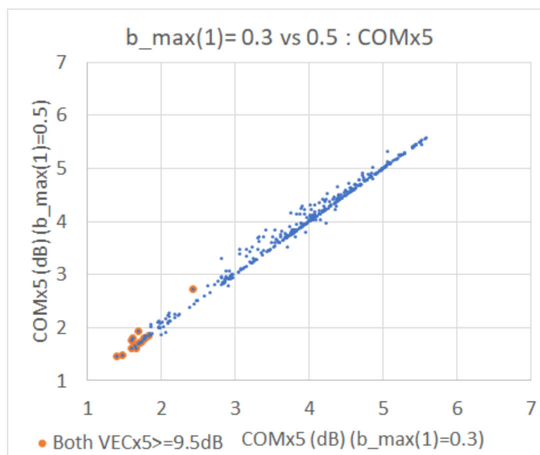
- Compared to $b_{max}(1)=0.3$, VEC and COM are improved with $b_{max}(1)=0.5$ for some cases.
- Improvement is observed more often in good cases.

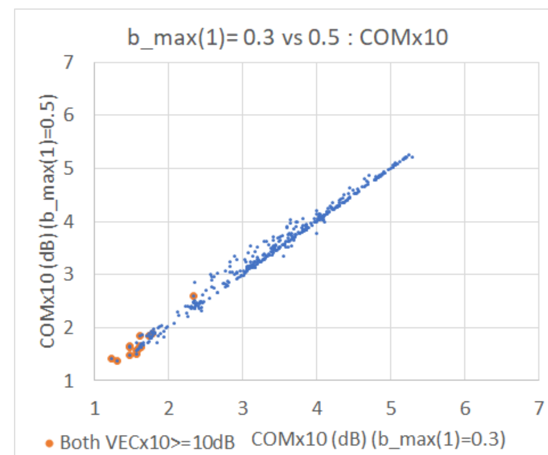






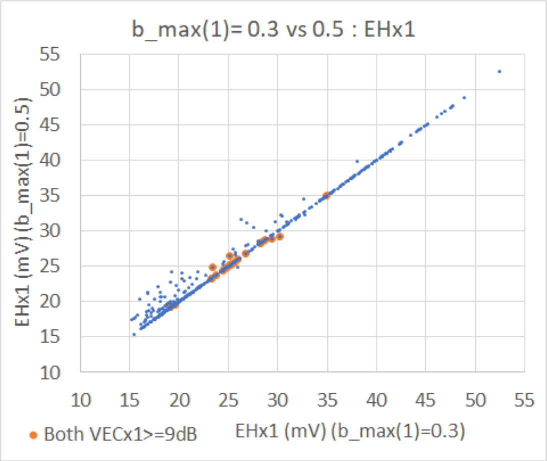


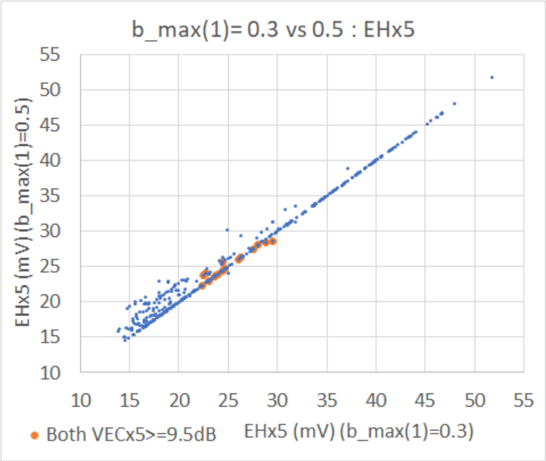


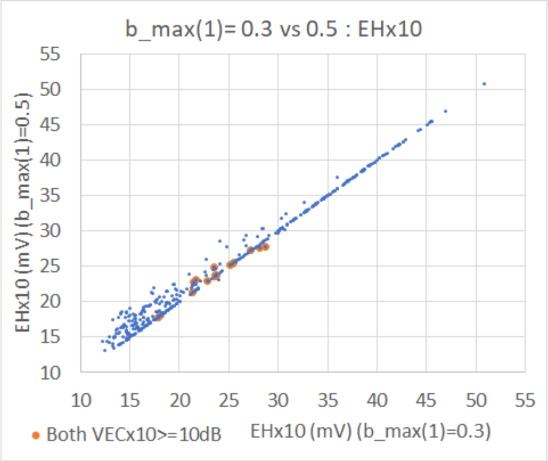


$b_{max}(1)$=0.3 vs $b_{max}(1)$=0.5: EH

- Compared to $b_{max}(1)$=0.3, EH is improved with $b_{max}(1)$=0.5 for some cases.
- Improvement is observed more often in small EH values, i.e. high loss channels.







Summary

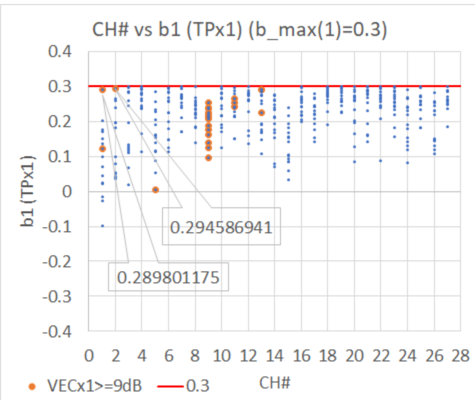
- Recommend 4.1e-8 V^2/GHz as receiver noise, and 9dB VEC at TP1a.
- $B_{max}(1)$ = 0.5 or 0.3 have some performance impact but not significant.
- $B_{max}(1)$ = 0.5 allows smaller range of tail DFE taps.
- Possible parameters for DFE and EH:

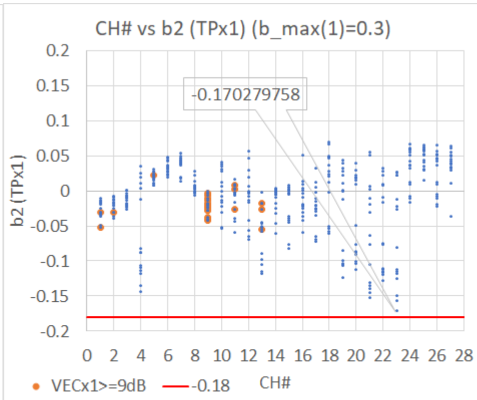
	Option A	Option B
$b_{max}(1)$	0.5	0.3
$b_{max}(2)$	0.15	0.2
$b_{max}(3)$	0.1	0.1
$b_{max}(4)$	0.05	0.05
EH (mV) (min)	14.0	13.5

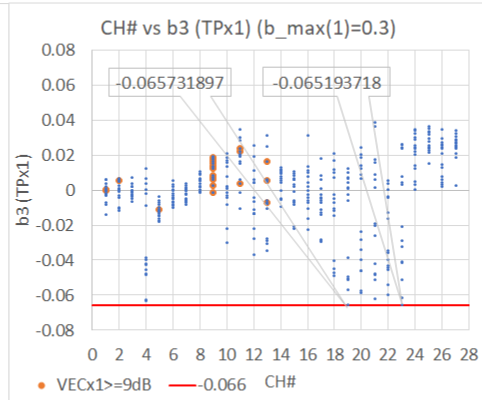
Backup Slides

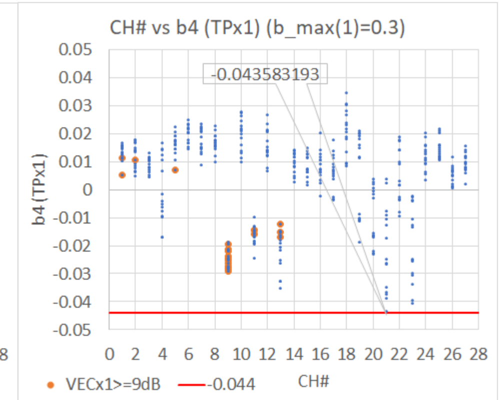
DFE Tap Weight Range with x1 Rx noise

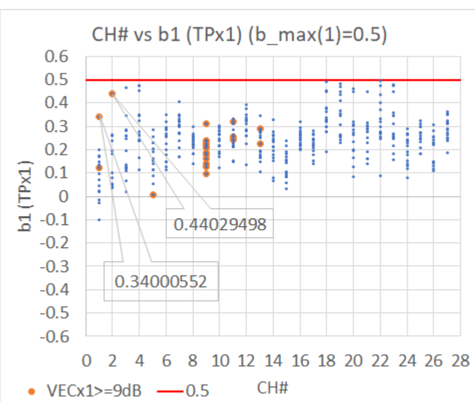
- x1 Rx noise for all plots. Top plots show b[1-4] with $b_{max}(1)=0.3$, and bottom plots with $b_{max}(1)=0.5$.
- b[1-4] for $b_{max}(1)=0.3$ and b1 for $b_{max}(1)=0.5$ are similar to the results with x5 Rx noise.
- b[2-4] for $b_{max}(1)=0.5$ are closer to $b_{max}(1)=0.3$ than the results with x5 Rx noise.
  - Namely, the effect of $b_{max}(1)$ on the b[2-4] range is less significant in comparison to x5 Rx noise.

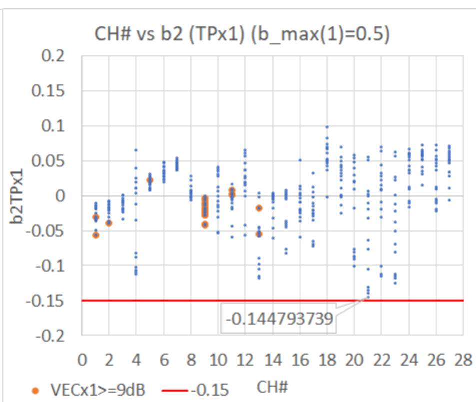


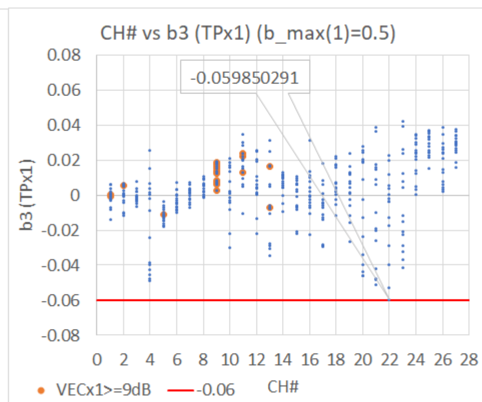


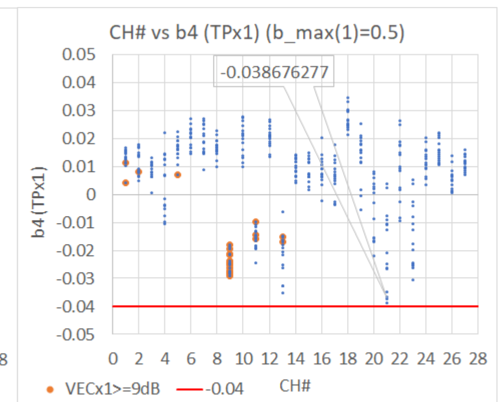






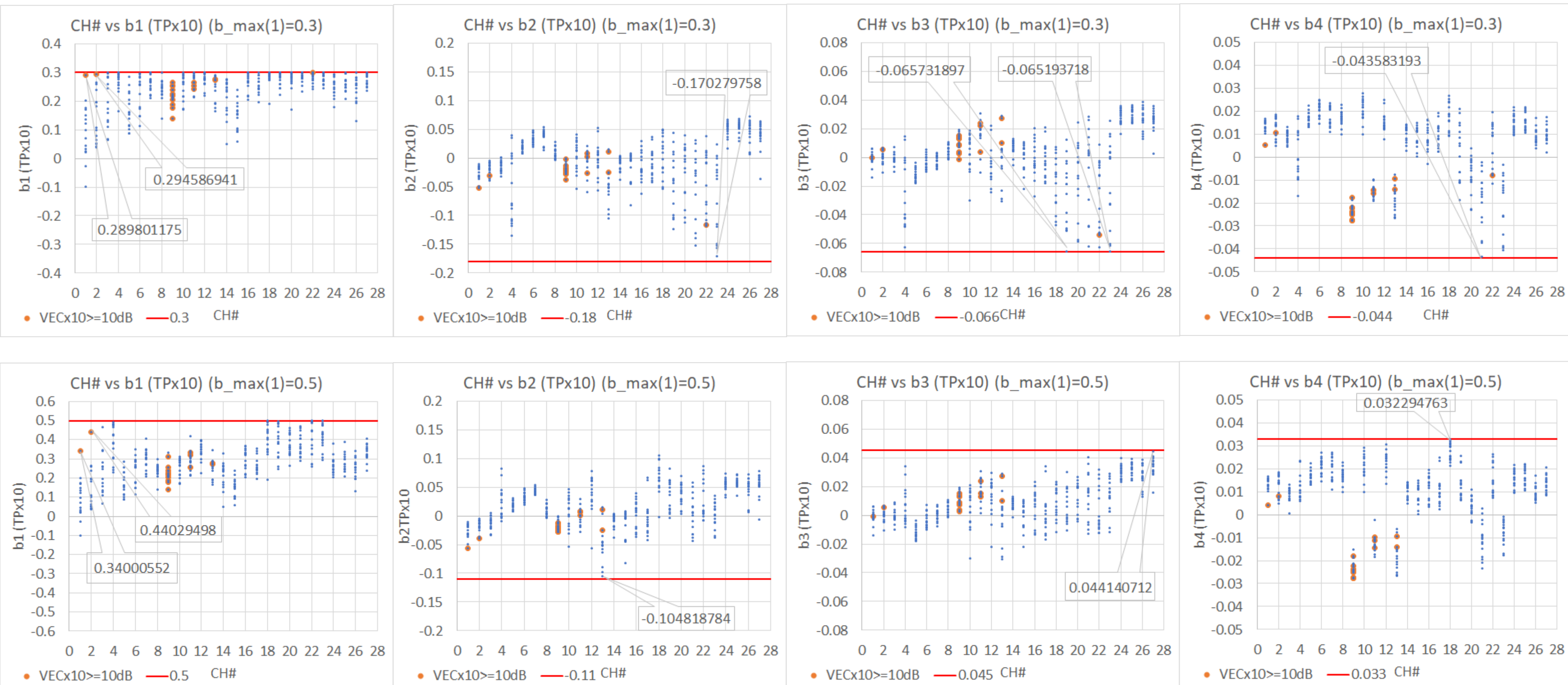






DFE Tap Weight Range with x10 Rx noise

- x10 Rx noise for all plots. Top plots show b[1-4] with $b_{max}(1)$=0.3, and bottom plots with $b_{max}(1)$=0.5.
- b[1-4] for $b_{max}(1)$=0.3 and b1 for $b_{max}(1)$=0.5 are similar to the results for x5 Rx noise.
- b[2-4] for $b_{max}(1)$=0.5 are more different from $b_{max}(1)$=0.3 compared to x5 Rx noise.
  - Namely, the effect of $b_{max}(1)$ on the b[2-4] range is more significant compared to x5 Rx noise.



TP1a COM Spread Sheet

Table 93A-1 parameters				I/O control			Table 93A–3 parameters		
Parameter	Setting	Units	Information	DIAGNOSTICS	1	logical	Parameter	Setting	Units
f_b	53.125	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	6.141E-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			
L_s	[0.12, 0]	nH	[TX RX]	Port Order	[1 3 2 4]		Table 92–12 parameters		
C_b	[0.3e-4 0]	nF	[TX RX]	RUNTAG	C2M TP1a		Parameter	Setting	
z_p select	[1]		[test cases to run]	COM_CONTRIBUTION	0	logical	board_tl_gamma0_a1_a2	[0 3.8206e-04 9.5909e-05]	
z_p (TX)	[13 30; 1.8 1.8]	mm	[test cases]	Operational			board_tl_tau	5.790E-03	ns/mm
z_p (NEXT)	[0 0; 0 0]	mm	[test cases]	COM Pass threshold	3	dB	board_Z_c	90	Ohm
z_p (FEXT)	[13 30; 1.8 1.8]	mm	[test cases]	ERL Pass threshold	10.5	dB	z_bp (TX)	119	mm
z_p (RX)	[0 0; 0 0]	mm	[test cases]	DER_0	1.00E-05		z_bp (NEXT)	119	mm
C_p	[0.87e-4 0]	nF	[TX RX]	T_r	6.16E-03	ns	z_bp (FEXT)	119	mm
R_0	50	Ohm		FORCE_TR	1	logical	z_bp (RX)	119	mm
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	2.40E+9				
c(-1)	[-0.3:0.02:0]		[min:step:max]	rho_x	0.30				
c(-2)	[0:.02:0.1]		[min:step:max]	fixture delay time	0	enter sec			
c(-3)	[-0.04:.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	4	UI		Receiver testing					
b_max(1)	0.5			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								
Floating Tap Control									
N_bg	0		0 1 2 or 3 groups						
N_bf	0		taps per group						
N_f	40		UI span for floating taps						
bmaxg	0.05		max DFE value for floating taps						

Whole-link COM Spread Sheet

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]		[test cases to run]
z_p (TX)	[13 30; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[6 2; 0 0]	mm	[test cases]
z_p (FEXT)	[13 30; 1.8 1.8]	mm	[test cases]
z_p (RX)	[6 2; 0 0]	mm	[test cases]
C_p	[0.87e-4 0.75e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[45, 50]	Ohm	[TX RX]
A_v	0.391	V	vp/vf=.694
A_fe	0.391	V	vp/vf=.694
A_ne	0.489	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.3:0.02:0]		[min:step:max]
c(-2)	[0:.02:0.1]		[min:step:max]
c(-3)	[-0.04:.02:0.0]		[min:step:max]
c(1)	[-0.1:0.05:0]		[min:step:max]
N_b	4	UI	
b_max(1)	0.5		
b_max(2..N_b)	0.2		
g_DC	[-14:1:-3]	dB	[min:step:max]
f_z	12.58	GHz	
f_p1	20	GHz	
f_p2	28	GHz	
g_DC_HP	[-3:1:0]		[min:step:max]
f_HP_PZ	1.328125	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		
Floating Tap Control			
N_bg	0		0 1 2 or 3 groups
N_bf	4		taps per group
N_f	40		UI span for floating taps
bmaxg	0.05		max DFE value for floating taps

I/O control		
DIAGNOSTICS	0	logical
DISPLAY_WINDOW	0	logical
CSV_REPORT	1	logical
RESULT_DIR	.\TestCaseFloatingBank\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M end-to-end	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	10.5	dB
DER_0	1.00E-05	
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	400	
TDR_Butterworth	1	logical
beta_x	2.40E+9	
rho_x	0.30	
fixture delay time	0	enter sec
TDR_W_TXPKG	1	
N_bx	4	UI
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