

An Updated 212.5 Gbps-PAM4 Link Simulations and Analyses for KR and CR Channels Using COM 4.60 Beta4

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212.5 Gbps-PAM4 KR/CR COM Performance Investigations

- Background

- A series COM simulations had been conducted, based on the latest available COM methodology/code, COM configuration checked and calibrated with the available test chip silicon and design, and available contributed KR/CR channels, at times [1],[2]
- Those results had been used to develop the specifications (i.e., D1.0/D1.1 [3])
- There are remaining TBDs in the latest D1.1 spec which need to be filled

- Goal

- Conducted new and updated COM simulations for KR/CR for filling-in the TBDs and the proposed appropriate changes
 - Using the latest COM V4.6B4
 - Using the latest KR/CR channels contributed to the 802.3dj (a total of 111)
 - COM configuration calibrated with the latest test chip silicon and design

KR/CR Channels Used for Investigation

Ch id	Channel Type	Channel Source	
1	CR	https://www.ieee802.org/3/dj/public/tools/CR/lim_3dj_04_230629.zip	
2	CR	https://www.ieee802.org/3/dj/public/tools/CR/lim_3dj_03_230629.zip	
3~7	CR	https://www.ieee802.org/3/dj/public/tools/CR/kocsis_3dj_02_2305.zip	
8~34	KR	https://www.ieee802.org/3/dj/public/tools/KR/mellitz_3dj_02_elec_230504.zip	
35~40	CR	https://www.ieee802.org/3/dj/public/tools/CR/shanbhag_3dj_01_2305.zip	
41~44	KR	https://www.ieee802.org/3/dj/public/tools/KR/shanbhag_3dj_02_2305.zip	
45~80	KR	https://www.ieee802.org/3/dj/public/tools/KR/weaver_3dj_02_2305.zip	
81~88	KR	https://www.ieee802.org/3/dj/public/tools/KR/weaver_3dj_elec_01_230622.zip	
89~95	KR	https://www.ieee802.org/3/dj/public/tools/KR/akinwale_3dj_01_2310.zip	newly added in our analysis
96~99	CR	https://www.ieee802.org/3/dj/public/tools/CR/akinwale_3dj_02_2311.zip	newly added in our analysis
100-111	CR	https://www.ieee802.org/3/dj/public/tools/CR/weaver_3dj_02_2311.zip	newly added in our analysis

Updated COM Configuration with Change Highlights

- TX
 - Package: Class A reference package with TLine length 33+1.8mm
 - TX FFE: **1 pre-tap (limited tap investigation is mainly due to the long simulation time constraint)**
- RX
 - Package: Class A reference package with TLine length 31+1.8mm
 - CTLE/f_r
 - [fp1, fp2, fz, f_HP_PZ] = fb / [2.6562, 1.8973, 4.223, 80] Hz
 - g_DC = [-15:1:0]
 - g_DC_HP = [-5:1:0]
 - **f_r: 0.55**
 - FFE:
 - **23 fixed taps (6 pre-taps and 16 post-taps)**
 - **10 floating taps (2 groups of 5 consecutive taps) up to 80 UI**
 - Coefficient Range: Main tap fixed to 1, abs(Max) = 0.7 for fixed taps, abs(Max) = 0.05 for floating taps
 - MLSE:
 - 1 tap with max coefficient b_max = 0.85
 - EQ tuning methods
 - FFE_OPT_METHOD = MMSE
 - CDR Phase (ts_anchor)
 - ts_anchor=1 with range [-16, 16]
 - TS_SRCH_METHOD=Full-Sweep
 - DER0/Jitter/Noise
 - **DER0: 2e-4**
 - **eta0: 1e-8 (to align with the adopted eta0 for AUI C2C which has an IL close to 40 dB KR/CR)**

Changes, from Modified COM Config Set 3 as in [2], were marked in red.

Used COM v4.60b4 for this study.

COM Configuration

(TX EQ 1-pretap/eta0=1e-8/RX FFE 6-16-2-5-80 shown)

Table 93A-1 parameters			
Parameter	Setting	Units	Information
f_b	106.25	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[0.4e-4 0.9e-4 1.1e-4 ; 0.4e-4 0.9e-4 1.1e-4]	nF	[TX RX]
L_s	[.13 .15 .14; .13 .15 .14]	nH	[TX RX]
C_b	[0.3e-4, 0.3e-4]	nF	[TX RX]
z_p select	[2]		[test cases to run]
z_p (TX)	[12 33; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (FEXT)	[12 33; 1.8 1.8]	mm	[test cases]
z_p (RX)	[12 31; 1.8 1.8]	mm	[test cases]
C_p	[0.4e-4 0.4e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[46.25 46.25]	Ohm	[TX RX]
A_v	0.413	V	
A_fe	0.413	V	
A_ne	0.608	V	
AC_CM_RMS	0	V	[test cases]
L	4		
M	32		
filter and Eq			
f_r	0.55	*fb	
c(0)	0.54		min
c(-1)	[-0.4:0.02:0]		[min:step:max]
c(-2)	0		[min:step:max]
c(-3)	0		[min:step:max]
c(-4)	0		[min:step:max]
c(-5)	0		[min:step:max]
c(-6)	0		[min:step:max]
c(1)	0		[min:step:max]
N_b	1	UI	
b_max(1)	0.85		
b_max(2..N_b)	[0.3 0.2*ones(1,22)]		
b_min(1)	0.3		
b_min(2..N_b)	[-0.3 -0.2*ones(1,22)]		
g_DC	[-15:1:0]	dB	[min:step:max]
f_z	25.16	GHz	
f_p1	40.00	GHz	
f_p2	56.00	GHz	
g_DC_HP	[-5:1:0]		[min:step:max]
f_HP_PZ	1.328125	GHz	
MLSE	1		
ffe_pre_tap_len	6		
ffe_post_tap_len	16		
ffe_tap_step_size	0		
ffe_main_cursor_min	0.7		
ffe_pre_tap1_max	0.7		
ffe_post_tap1_max	0.7		
ffe_tapn_max	0.7		
ffe_backoff	0		

sample_adjustment	[-16, 16]		
ts_anchor	1		
RXFFE FLOAT CTL	FOM		
FFE_OPT_METHOD	MMSE		
TS_SRCH_METHOD	Full-Sweep		
num_ui_RXFFE_noise	2048		

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	\\results\100GEL_KR_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	KR_eval	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	8	dB
DER_0	0.0002	
T_r	0.004	ns
FORCE_TR	1	logical
Local Search	2	
BREAD_CRUMBS	1	logical
SAVE_CONFIG2MAT	1	logical
PLOT_CM	0	
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	3500	
beta_x	0	
rho_x	0.618	
fixture delay time	[0 0]	[port1 port2]
TDR_W_TXPKG	0	
N_bx	21	UI
Tukey_Window	1	logical
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	1.00E-08	V^2/GHz
SNR_TX	33	dB
R_LM	0.95	

Table 93A-3 parameters		
Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0.0005 0.00089 0.0002]	
package_tl_tau	0.006141	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	100	Ohm
z_bp (TX)	110.3	mm
z_bp (NEXT)	110.3	mm
z_bp (FEXT)	110.3	mm
z_bp (RX)	110.3	mm
C_0	[0.29e-4]	nF
C_1	[0.19e-4]	nF
Include PCB	0	logical
Floating Tap Control		
N_bg	2	0 1 2 or 3 groups
N_bf	5	taps per group
N_f	80	UI span for floating taps
bmaxg	0.05	max DFE value for floating taps
B_float_RSS_MAX	0.02	rss tail tap limit
N_tail_start	17	(UI) start of tail taps limit
ICN & FOM_ILD parameters		
f_v	0.556	*Fb
f_f	0.556	*Fb
f_n	0.556	*Fb
f_2	80.000	GHz
A_ft	0.600	V
A_nt	0.600	V

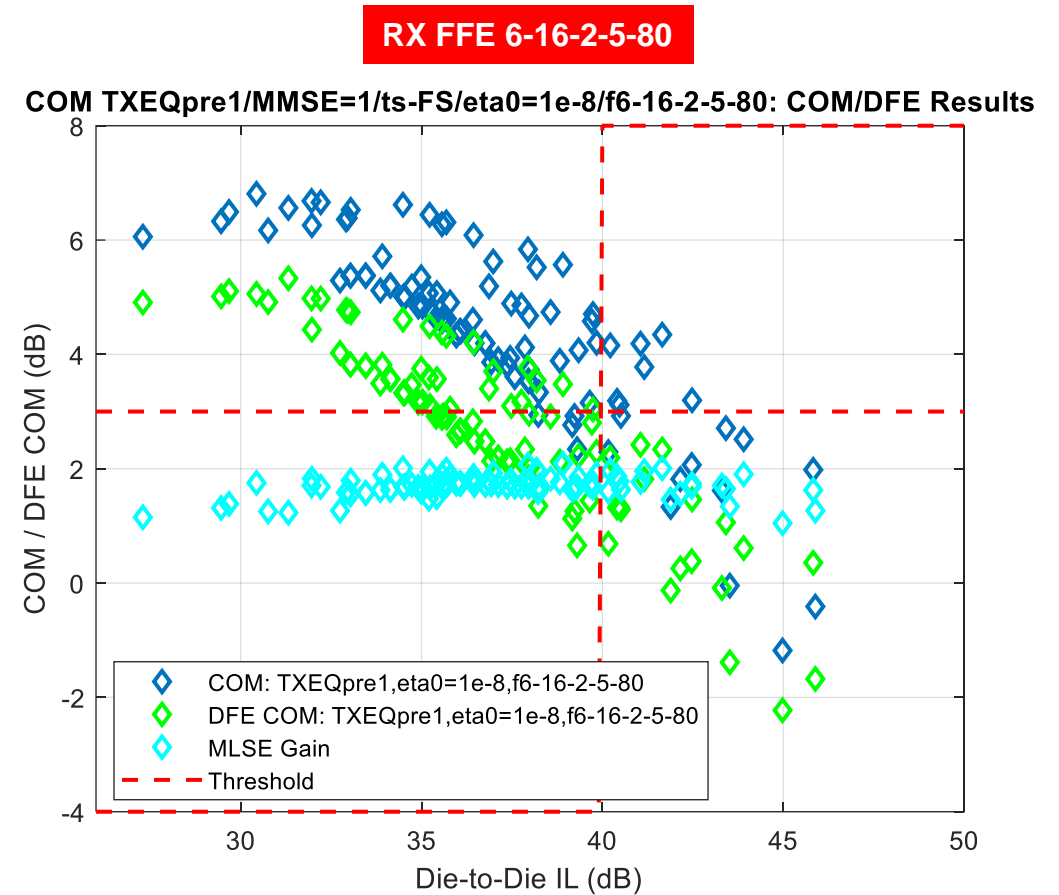
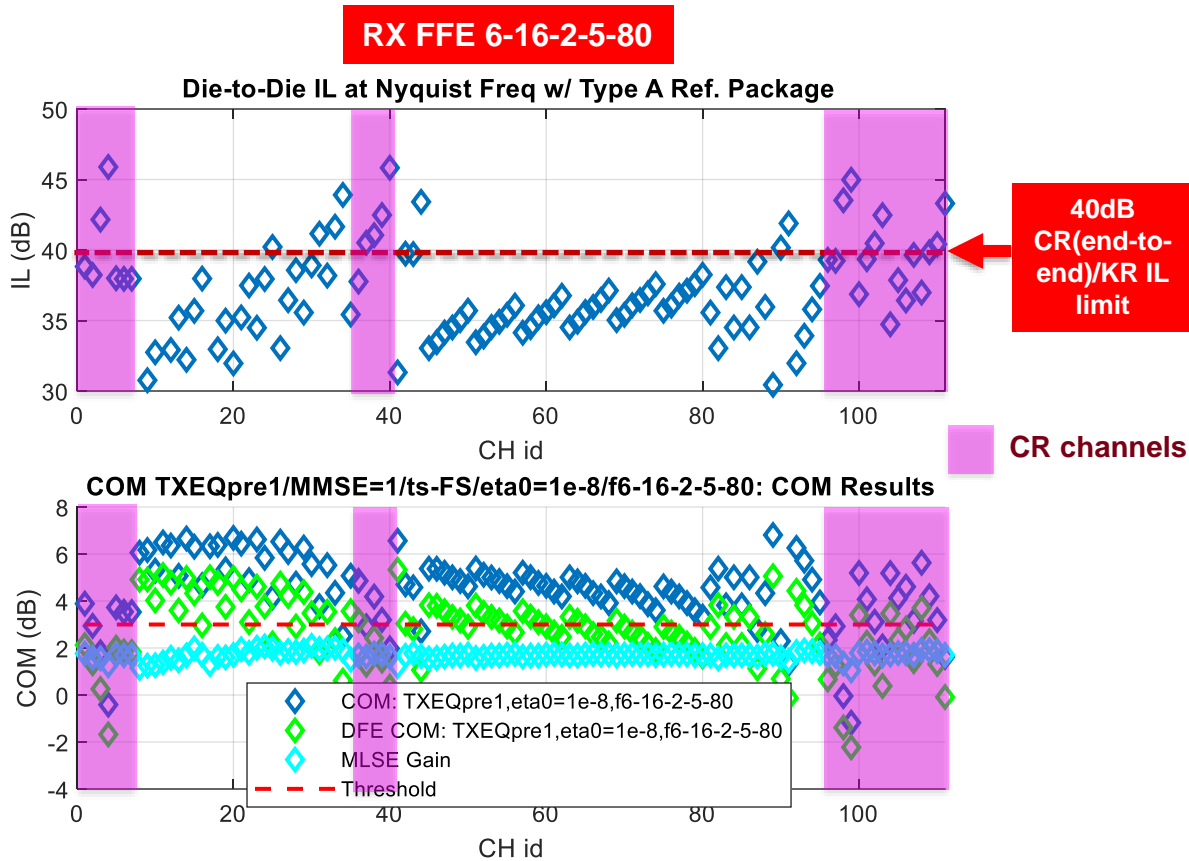
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V

Notes:

- Parameters related to this study are marked in yellow
- COM v4.60b4 was used in this study

IEEE 82.3dj CR/KR Test Channels IL and COM

RX $\eta_{a0}=1e-8$, FFE w/ 6 pre-taps, 16 post-taps, 2 groups of 5 consecutive taps, up to 80 UI



- COM pass rate = 85.6% (95 of 111 cases)

- <40dB IL, >3dB COM pass rate = 95.7% (88 out of 92 cases)

Summary and Conclusions

- Comprehensive COM (using latest COM V4.6B4) simulations based on all the KR/CR channels available to 802.3dj, and the latest updated COM configuration, have shown:
 - 3 dB COM pass rate among all 111 KR/CR test channels is 85.6%
 - Die-to-die IL \leq 40 dB, with 3 dB COM pass rate is 95.7%
- The COM configuration will be used as the basis for filling-in the TBDs and the proposed appropriate changes for D1.1 specification.

References

- [1] https://www.ieee802.org/3/dj/public/24_05/lim_3dj_01_2405.pdf
- [2] https://www.ieee802.org/3/dj/public/24_03/lim_3dj_02_2403.pdf
- [3] <https://www.ieee802.org/3/dj/private/index.html>

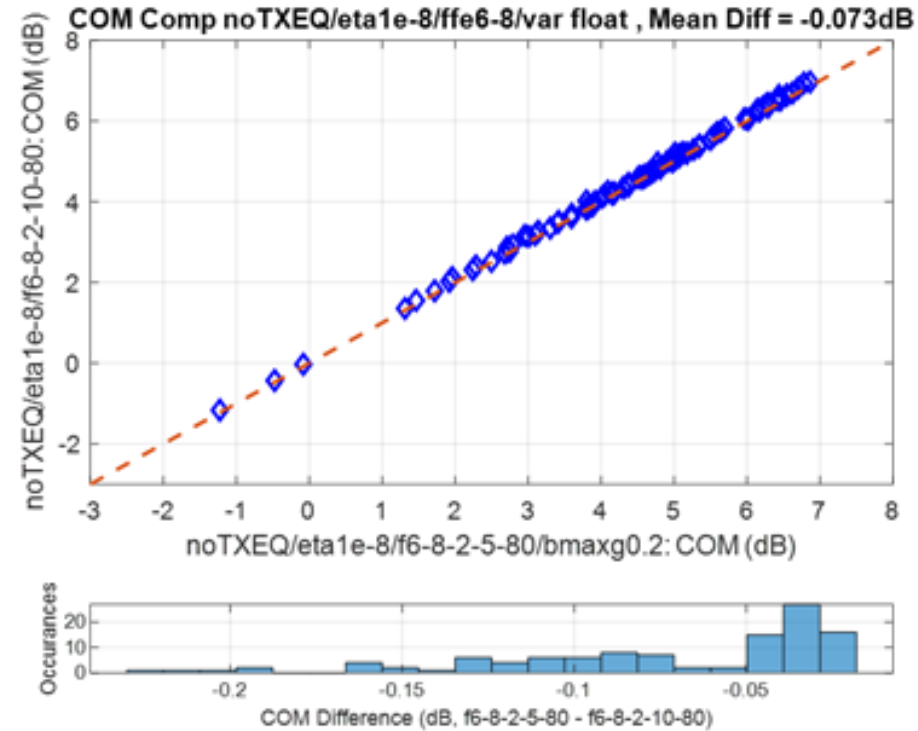
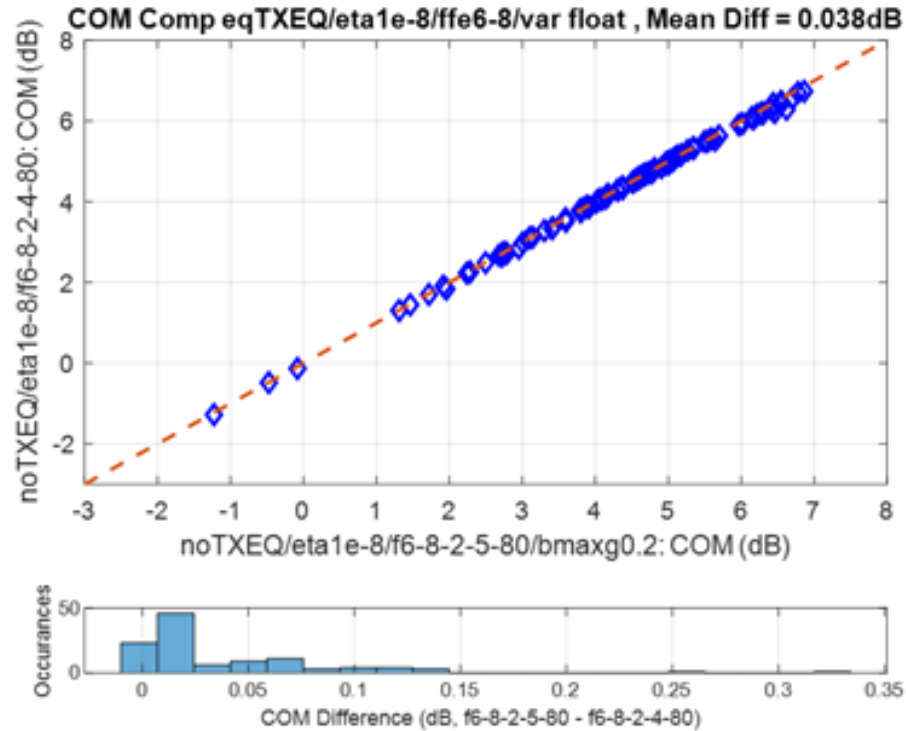
New COM Results

After Presentation Deadline

Sensitivity Analysis for Fixed and Floating Taps

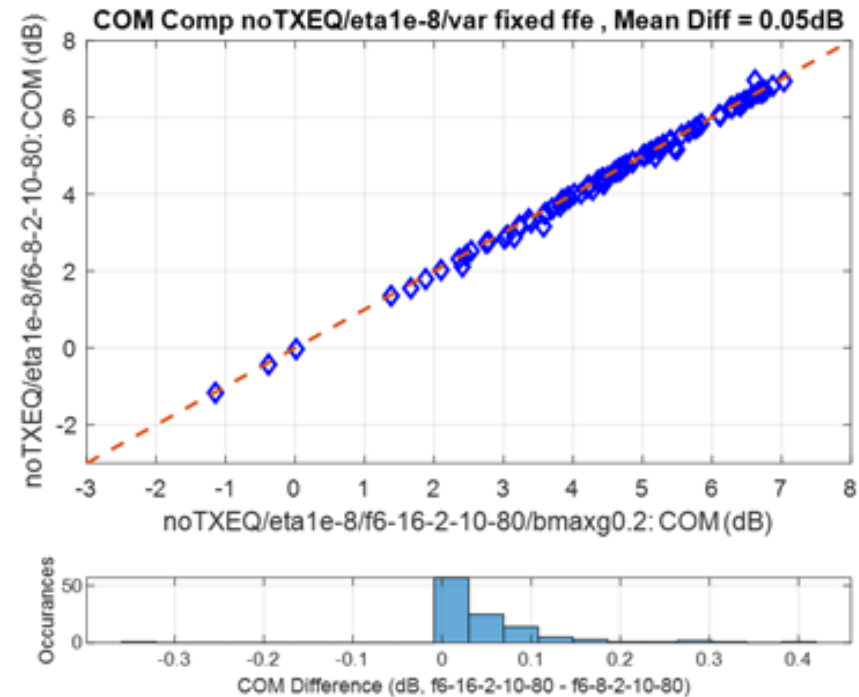
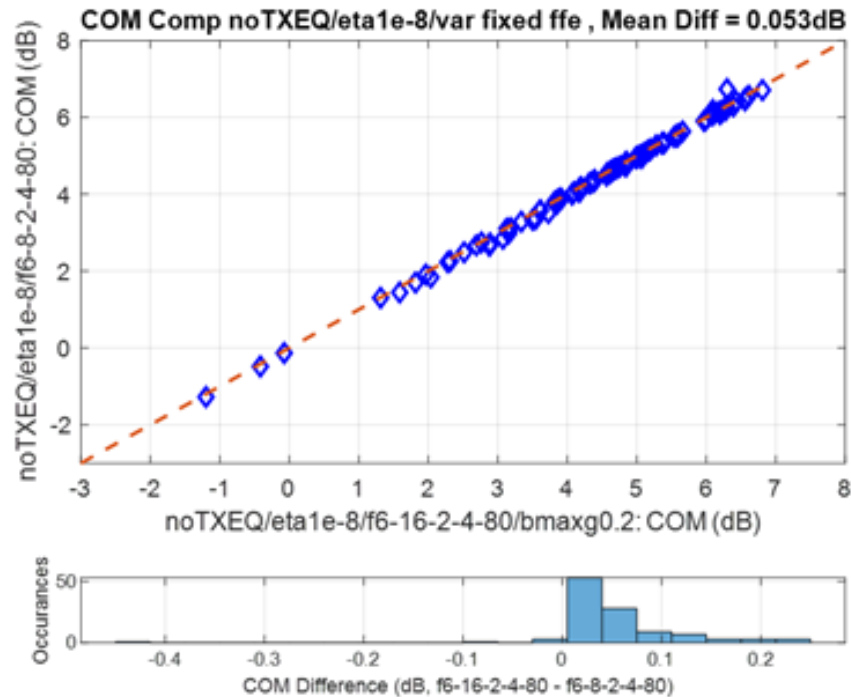
eta0 (v ² /GHz)	RX FFE (pre-post-Nbg- Nbf-Nf)	bmaxg	3dB Pass Rate (111 ch)	IL<40 & COM>3dB Pass Rate
1e-8	6-8-2-5-80	0.05	84.5%	95.7%
1e-8	6-8-2-5-80	0.2	84.5%	95.7%
1e-8	6-8-2-4-80	0.2	83.8%	95.7%
1e-8	6-8-2-10-80	0.2	85.6%	95.7%
1e-8	6-16-2-4-80	0.2	85.6%	95.7%
1e-8	6-16-2-10-80	0.2	88.3%	97.8%

Sensitivity Analysis for Fixed and Floating Taps Cont..



- Eta0=1e-8, ffe=6-8-2-5-80 vs ffe6-8-2-4-80, bmaxg 0.2 • Eta0=1e-8, ffe=6-8-2-5-80 vs ffe6-8-2-10-80, bmaxg 0.2
 - Mean COM diff = 0.0038dB
 - Mean COM diff = -0.073dB

Sensitivity Analysis for Fixed and Floating Taps Cont..



- Eta0=1e-8, ffe=6-16-2-4-80 vs ffe6-8-2-4-80, bmaxg 0.2
 - Mean COM diff = 0.053 dB

- Eta0=1e-8, ffe=6-16-2-10-80 vs ffe 6-8-2-10-80, bmaxg 0.2
 - Mean COM diff = 0.05 dB

Thank You!