COM Tool Runtime Assessment Using Local Search and Sample Adjustment

Hansel D'Silva
Amphenol Corporation

IEEE 802.3 Channel Operating Margin (COM) Open Source Project Ad Hoc

History

Revision	Date	Comment
0.5	31-May-2026	▪ Initial Draft.

1. Problem Statement

- How can COM runtime be reduced using Local Search and optimized sample adjustment ranges while maintaining accuracy and robustness?

2. Summary

- Evaluated 171 of the KR and CR channels posted on the 802.3dj Public Area.
  - Total cases= 171x4= 684 given two tests for package class A and package class B.
- The Full-Sweep Local Search shows 0.00 dB delta COM compared to the Exhaustive Full Search.
  - One may used Local Seach= 2 with TS_SRCH_MODE= full-sweep for 0.00 dB delta COM and noticeable run time reduction compared to Exhaustive Full Search.
- Local Search with TS_SRCH_MODE= middle is not recommended.
  - The Middle Local Search shows a large delta COM (greater than 1 dB) compared to the Exhaustive Full Search.
- sample_adustment= [-32 32] may be recommended.
  - sample_adustment= [-16 16] shows as much as 0.5 dB delta COM compared to sample_adustment= [-32 32].
  - As future work, it is recommended to explore reduced sample_adjustment, such as [-32, 0] or [-24, 0], to further improve runtime efficiency.

3. List of CR and KR Channels on 802.3dj Public Area

- Below are the 200 Gb/s CR and KR channel data (TP0 to TP5)- with crosstalk.
  1. akinwale_3dj_01_2311: x4
  2. weaver_3dj_02_2311: x12
  3. akinwale_3dj_01_2310: x7
  4. lim_3dj_07_2309: x1
  5. lim_3dj_04_230629: x1
  6. lim_3dj_03_230629: x1
  7. weaver_3dj_elec_01_230622: x8
  8. shanbhag_3dj_01_2305: x6
  9. shanbhag_3dj_02_2305: x4
  10. kocsis_3dj_02_2305: x5
  11. weaver_3dj_02_2305: x36
  12. mellitz_3dj_02_elec_230504: x27
  13. weaver_3dj_02_2303: x5
  14. mellitz_3dj_02_2303: x54

Table 178–14—Device termination and package model parameters

Parameter	Symbol	Value	Units
Device termination model			
Single-ended device capacitance for stage 1	$C_d^{(1)}$	40×10^{-6}	nF
Single-ended device capacitance for stage 2	$C_d^{(2)}$	90×10^{-6}	nF
Single-ended device capacitance for stage 3	$C_d^{(3)}$	110×10^{-6}	nF
Single-ended device series inductance for stage 1	$L_s^{(1)}$	0.13	nH
Single-ended device series inductance for stage 2	$L_s^{(2)}$	0.15	nH
Single-ended device series inductance for stage 3	$L_s^{(3)}$	0.14	nH
Single-ended bump capacitance	C_b	30×10^{-6}	nF
Device package model, class A			
Transmission line parameter γ_0	γ_0	5×10^{-4}	1/mm
Transmission line parameter a_1	a_1	8.9×10^{-4}	$ns^{1/2}$/mm
Transmission line parameter a_2	a_2	2×10^{-4}	ns/mm
Transmission line parameter τ	τ	6.141×10^{-3}	ns/mm
Transmission line 1 length, Test 1	$z_p^{(1)}$	33	mm
Transmission line 1 length, Test 2	$z_p^{(1)}$	12	mm
Transmission line 1 characteristic impedance	$Z_c^{(1)}$	87.5	Ω
Transmission line 2 length	$z_p^{(2)}$	1.8	mm
Transmission line 2 characteristic impedance	$Z_c^{(2)}$	92.5	Ω
Device package model, class B			
Transmission line parameter γ_0	γ_0	5×10^{-4}	1/mm
Transmission line parameter a_1	a_1	6.5×10^{-4}	$ns^{1/2}$/mm
Transmission line parameter a_2	a_2	2.93×10^{-4}	ns/mm
Transmission line parameter τ	τ	6.141×10^{-3}	ns/mm
Transmission line 1 length, Test 1, Tx / Rx	$z_p^{(1)}$	45 / 44	mm
Transmission line 1 length, Test 2, Tx / Rx	$z_p^{(1)}$	30 / 29	mm
Transmission line 1 characteristic impedance	$Z_c^{(1)}$	87.5	Ω
Transmission line 2 length	$z_p^{(2)}$	2	mm
Transmission line 2 characteristic impedance	$Z_c^{(2)}$	95	Ω
Transmission line 3 length	$z_p^{(3)}$	1.3	mm
Transmission line 3 characteristic impedance	$Z_c^{(3)}$	100	Ω
Transmission line 4 length	$z_p^{(4)}$	1.5	mm
Transmission line 4 characteristic impedance	$Z_c^{(4)}$	78	Ω

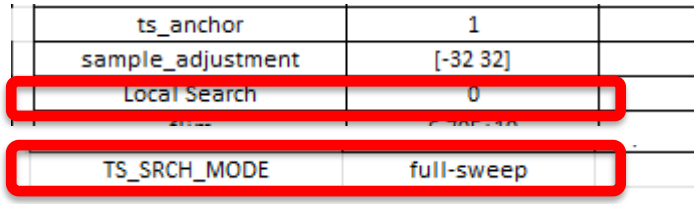
- Total of 171 channels from the IEEE 802.3dj Public Area are evaluated against the class A and class B package models.
  - ❑ Total cases= 171x4= 684 cases.

1. Local Search and TS_SRCH_MODE

A. COM Spreadsheet: Local Search and TS_SRCH_MODE

Name	Local Search	TS_SRCH_MODE
Exhaustive Full Search	0	Do Not Care
Full-Sweep Local Search	2	full-sweep
Middle Local Search	2	middle

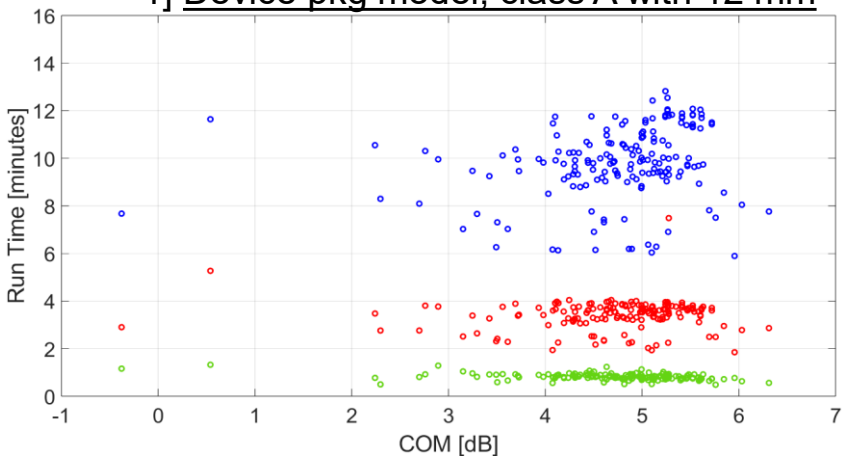
Example,



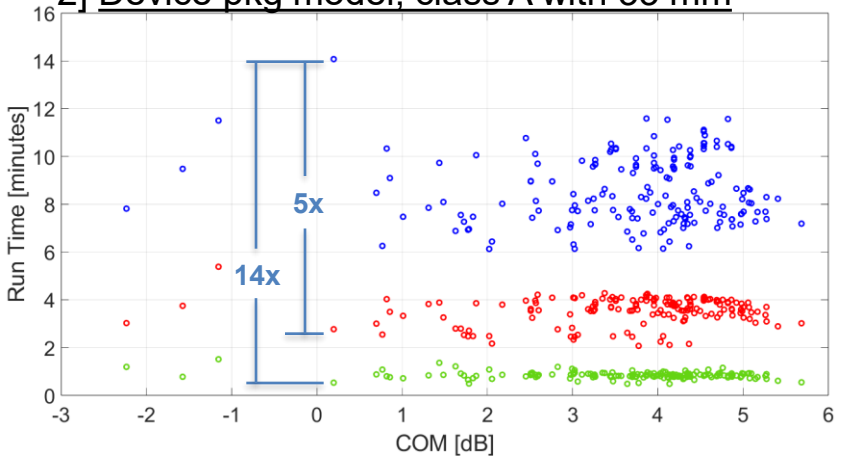
- As an alternative to exhaustive full search for runtime reduction, local search methods can be used.
  - Local search is triggered by setting Local Search to a non-zero value.
  - Local search operates using TS_SRCH_MODE, which can be either full-sweep or middle.
    - Take the example where sample_adustment= [-32 +32].
    - Full-sweep: evaluates sample offsets in a fixed linear order across the entire range, e.g., [-32, -31, …, 0, …, +31, +32], ensuring exhaustive coverage.
    - Middle: performs a center-out local search, e.g., [0, -1, +1, -2, +2, …., -32, +32], and typically terminates early when the FOM degrades, so it may not reach the full range (±32).

B. Results on Run Time

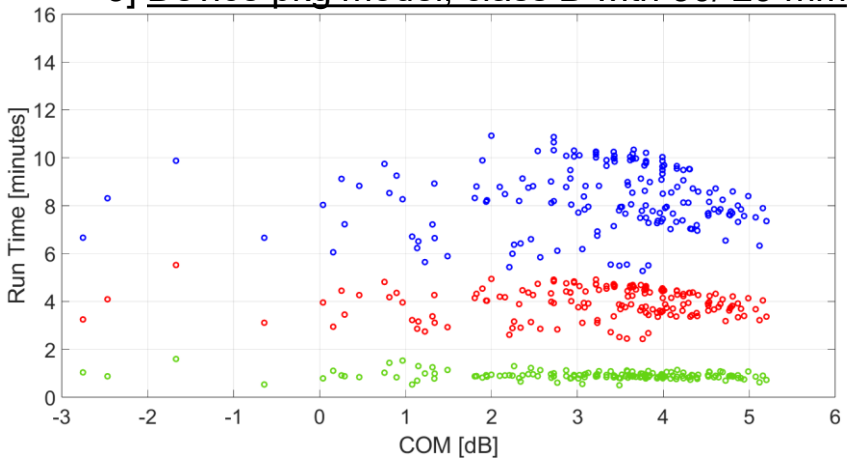
1] Device pkg model, class A with 12 mm



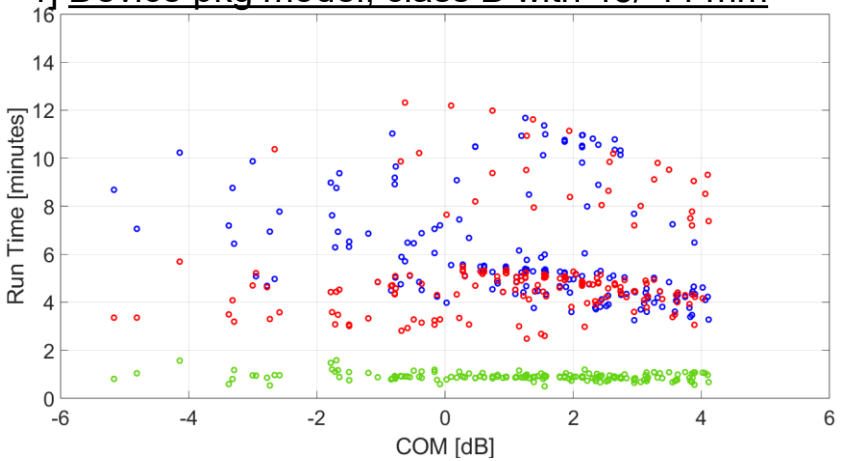
2] Device pkg model, class A with 33 mm



3] Device pkg model, class B with 30/ 29 mm



4] Device pkg model, class B with 45/ 44 mm



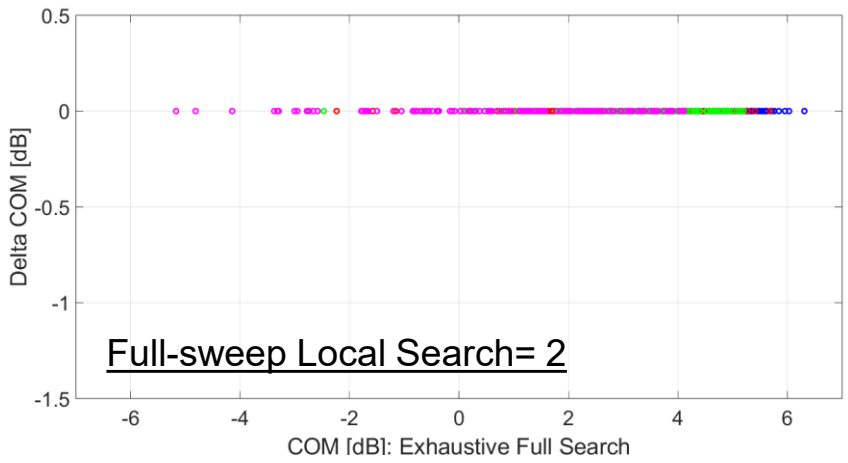
Exhaustive Full Search
Full-Sweep Local Search
Middle Local Search

Note. Local Search= 2 for Full-Sweep Local Search and Middle Local Search.

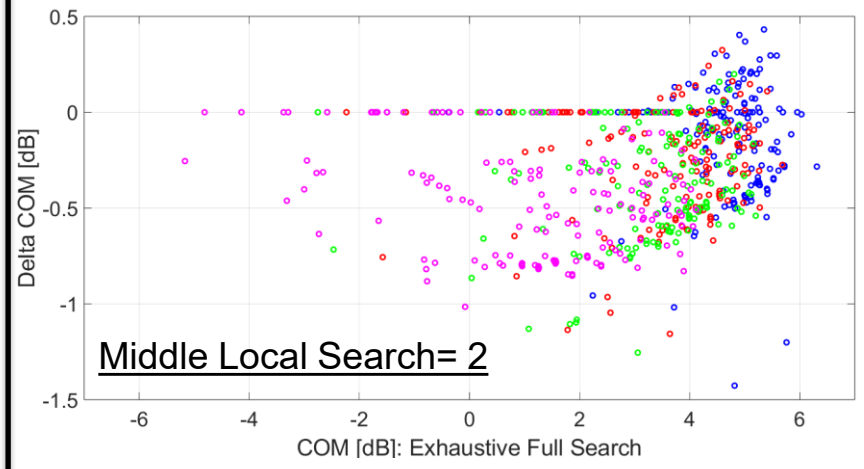
- The Full-Sweep Local Search achieves a 5x reduction in runtime compared to the Exhaustive Full Search.
- The Middle Local Search achieves a 14x reduction in runtime compared to the Exhaustive Full Search.

C. Results on COM: Page 1

1] Full-Sweep Local Search -Exhaustive Full Search



2] Middle Local Search -Exhaustive Full Search

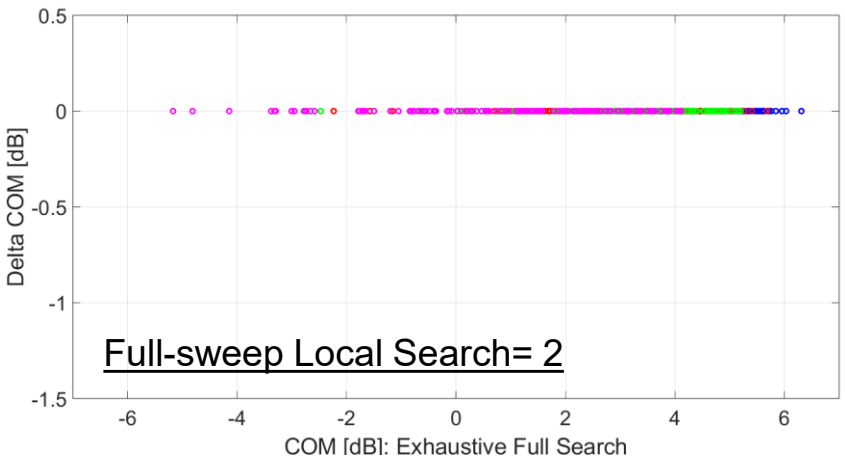


Device pkg model, class A with 12 mm
Device pkg model, class A with 33 mm
Device pkg model, class B with 30/ 29 mm
Device pkg model, class B with 45/ 44 mm

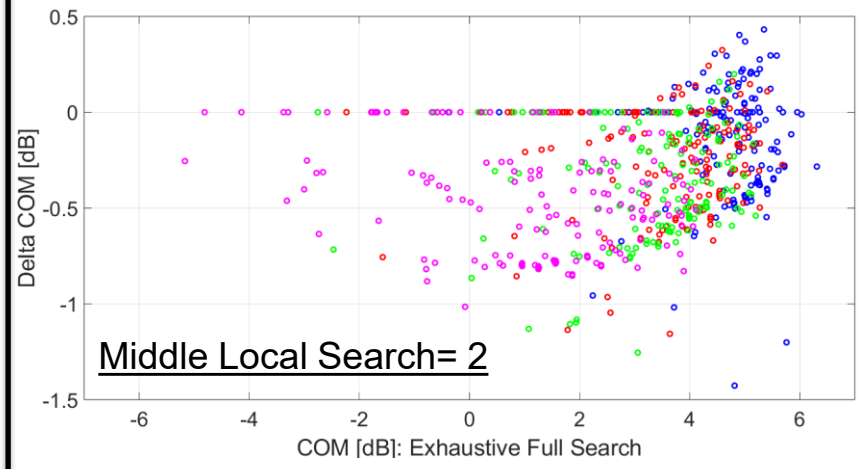
- The Full-Sweep Local Search shows 0.00 dB delta COM compared to the Exhaustive Full Search.
- The Middle Local Search shows a large delta COM (greater than 1 dB) compared to the Exhaustive Full Search.

C. Results on COM: Page 2

1] Full-Sweep Local Search -Exhaustive Full Search

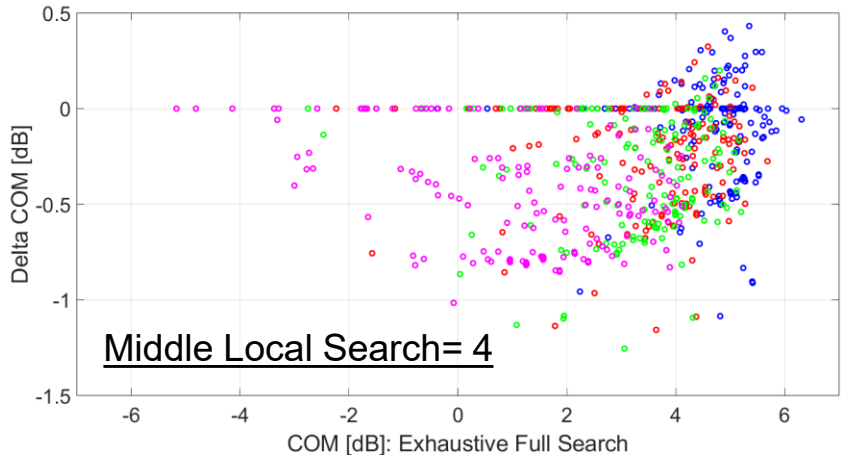


2] A. Middle Local Search -Exhaustive Full Search

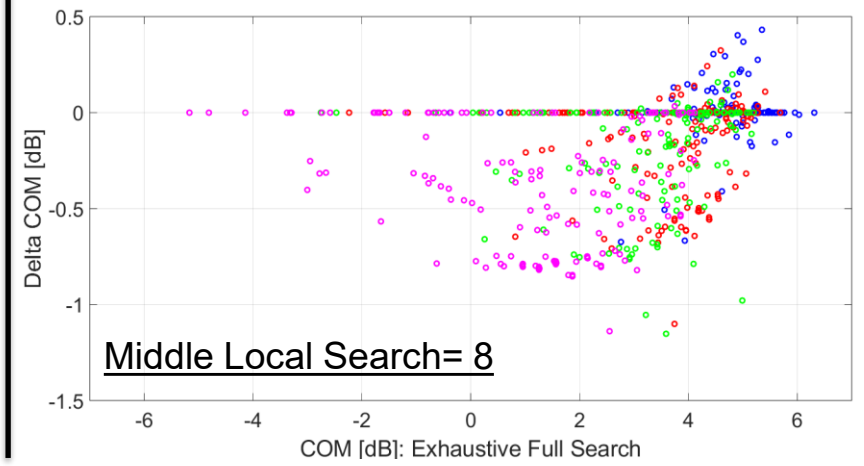


Device pkg model, class A with 12 mm
Device pkg model, class A with 33 mm
Device pkg model, class B with 30/ 29 mm
Device pkg model, class B with 45/ 44 mm

2] B. Middle Local Search -Exhaustive Full Search



2] C. Middle Local Search -Exhaustive Full Search



- The Middle Local Search may not be recommended.

2. sample_adjusment

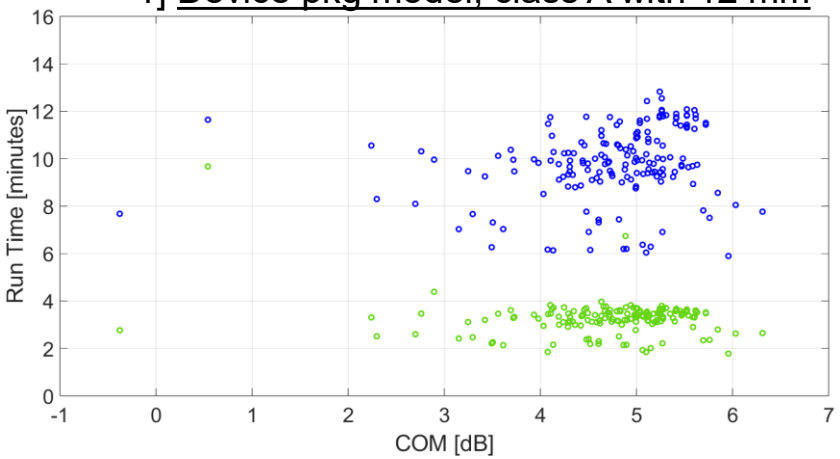
A. COM Spreadsheet: sample_adjustment

J	K	L	M
Operational			
ERL Pass threshold	11	dB	
COM Pass threshold	3	db	
DER_0	2.00E-04		
T_r	0.00400	ns	
FORCE_TR	1	logical	for legacy but require
PMD_type	C2C	for MMSE use C2C only	
EW	1		
MLSE	1	logical	
ts_anchor	1		
sample_adjustment	[-32 32]		
Local Search	0		
flim	6.70E+10	Hz	
zero_pad	1	logical	
Filter: By EEE			

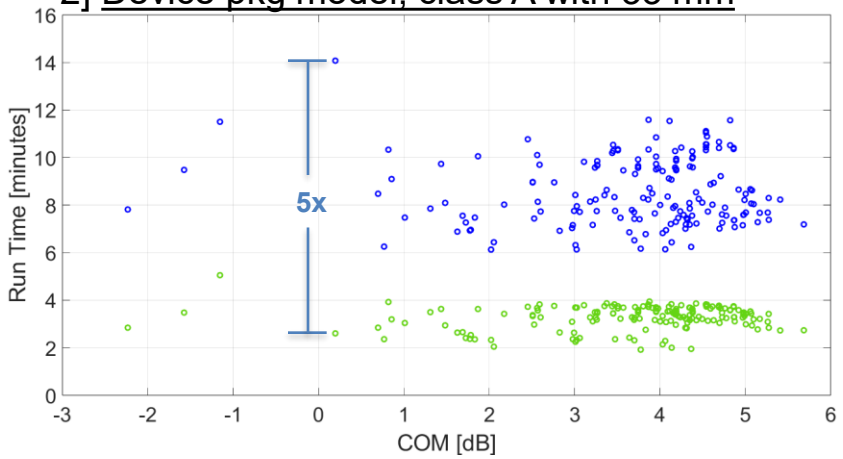
- Sample adjustment is the discrete time shift of the sampling point (relative to the cursor) that is swept to find the optimal sampling location for maximum FOM.

B. Results on Run Time

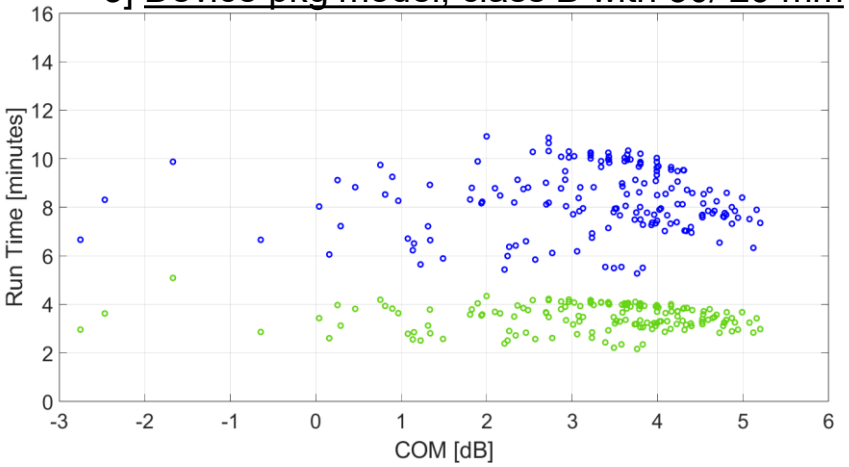
1] Device pkg model, class A with 12 mm



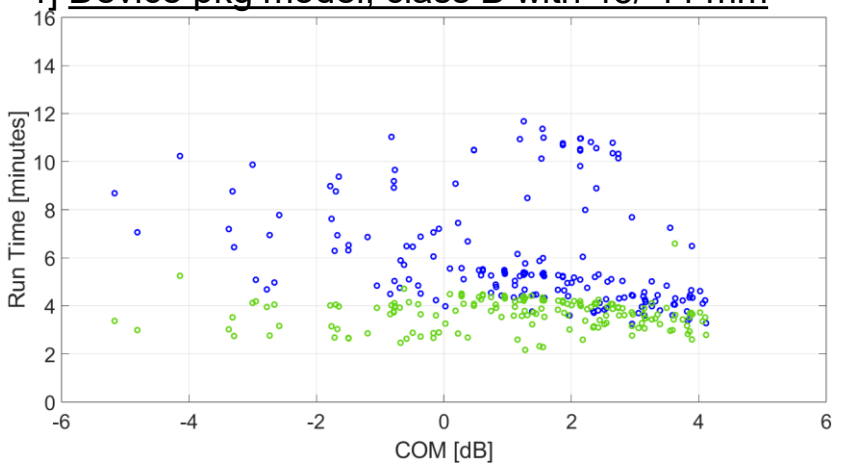
2] Device pkg model, class A with 33 mm



3] Device pkg model, class B with 30/ 29 mm



4] Device pkg model, class B with 45/ 44 mm

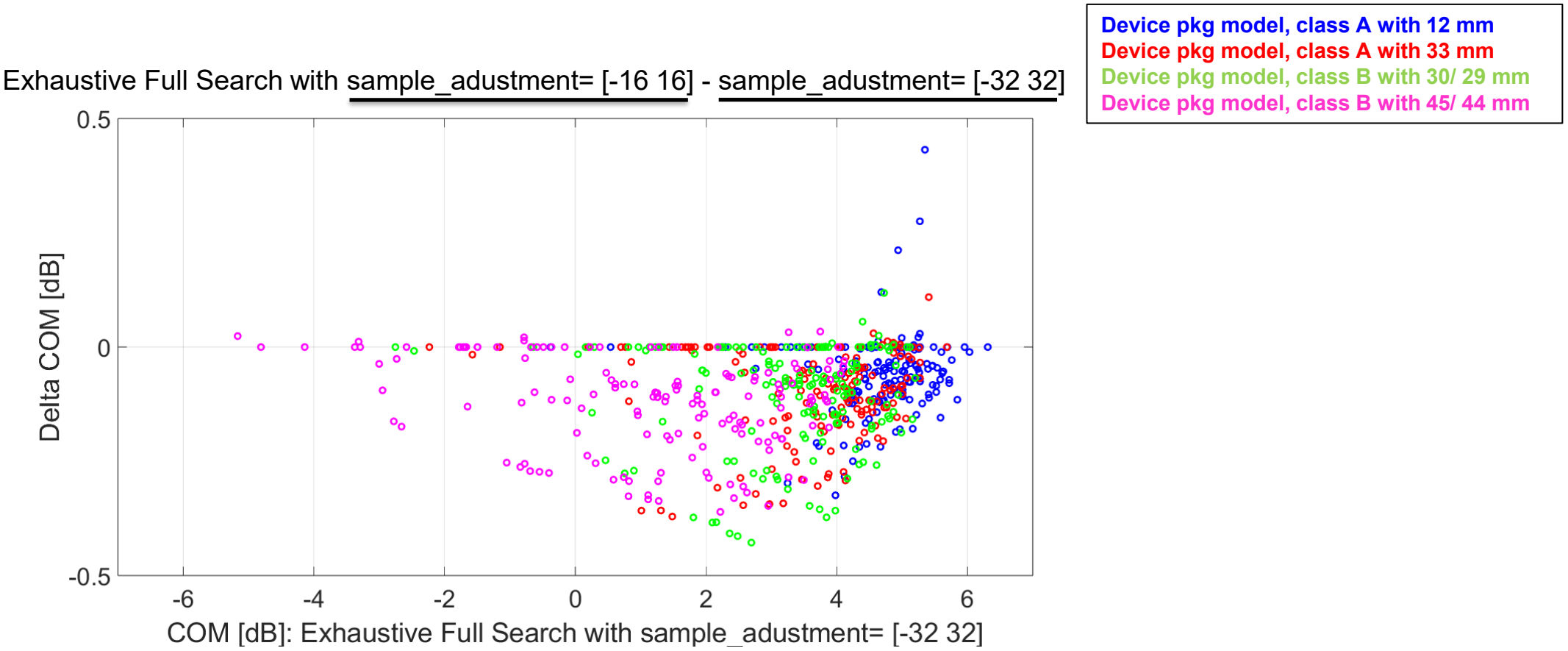


Exhaustive Full Search with sample_adustment= [-32 32]

Exhaustive Full Search with sample_adustment= [-16 16]

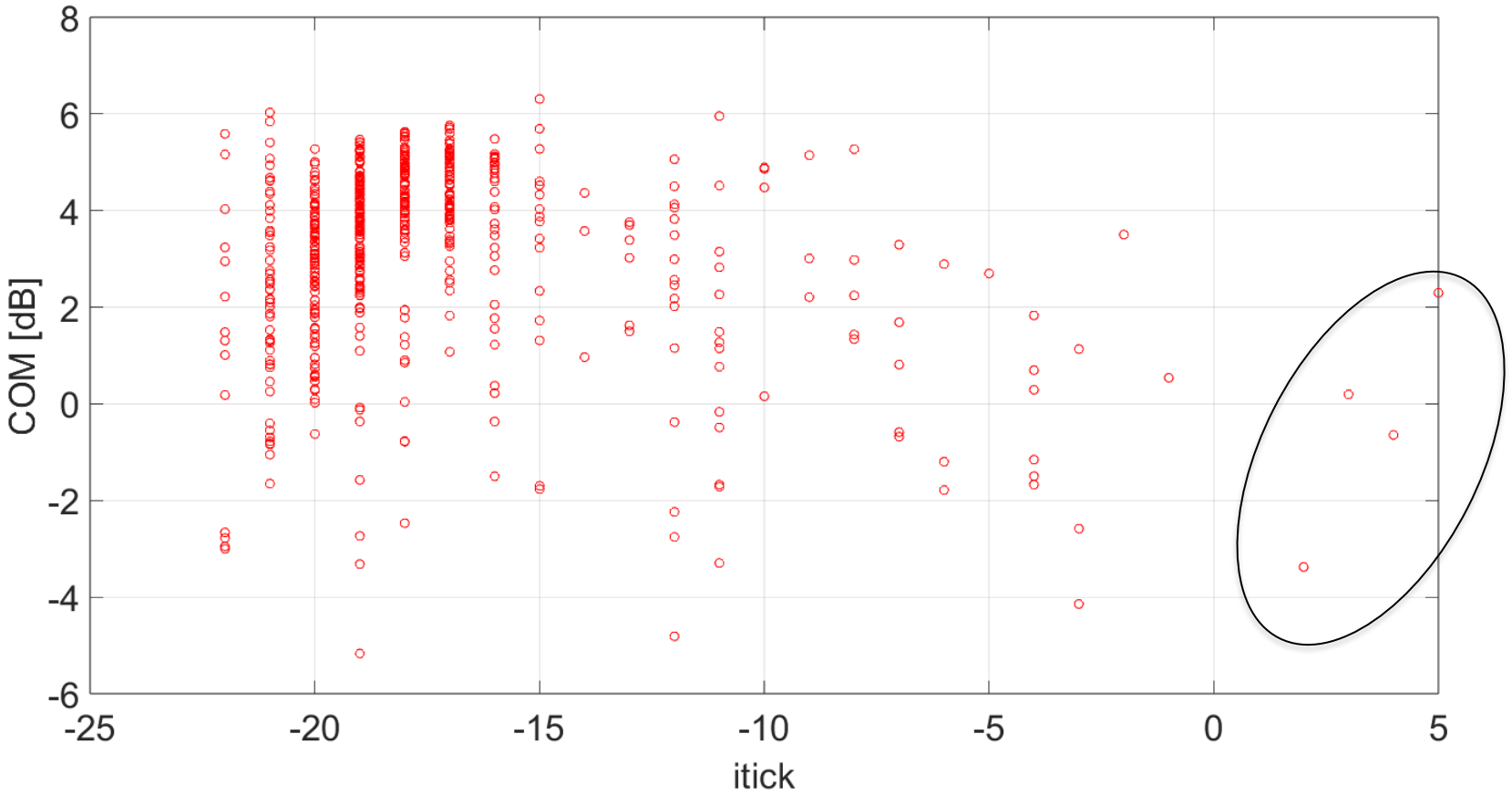
- A noticeable reduction in run time is observed in using sample_adustment= [-16 16] when compared to sample_adustment of [-32 32].

C. Results on COM



- sample_adustment= [-16 16] shows as much as 0.5 dB delta COM compared to sample_adustment= [-32 32].

D. Results on itick



Same channel
- Two tests for package class A and package class B.

- The itick values predominantly lie within the range of 0 to −24.
- A single channel appears as an outlier, exhibiting a positive itick value.
- As future work, it is recommended to explore reduced sample_adjustment, such as [-32, 0] or [-24, 0], to further improve runtime efficiency.

Thank you

COM Spreadsheet for Package Class A

data rate, die load, ref impedance			
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	[0.13 0.15 0.14; 0.13 0.15 0.14]	nH	[TX RX]
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]
R_0	46.25	Ohm	
PKG_NAME	**PKG_LowR_CLASSA PKG_LowR_CLASSA**		TX RX
z_p select	[1 2]		
L	4		
M	32		
filter and Eq			
f_r	0.55	*fb	
c(0)	0.55		min
c(-1)	0	[-0.34:.02:0]	[min:step:max]
c(-2)	0	[0.14:.02:0]	[min:step:max]
c(-3)	0		[min:step:max]
c(-4)	0		[min:step:max]
c(1)	0	[-0.2:.02:0]	[min:step:max]
N_b	1	UI	
b_max(1)	0.85		As/dffe1
b_max(2..N_b)	0		not used
b_min(1)	0		As/dffe1
b_min(2..N_b)	0	S	not used
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	42.50	GHz	
f_p1	42.50	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	1.328125	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\CAKR_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	KR_pkgA_	
COM_CONTRIBUTION	0	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	ns
TR_TDR	0.005	
N	7000	logical
TDR_Butterworth	1	
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	0	UI
N_bx	16	??
fixture delay time	[0 0]	
Tukey_Window	1	
Z_t	46.25	
Noise, jitter		UI
sigma_RJ	0.01	UI
A_DD	0.02	V^2/GHz
eta_0	7.50E-09	dB
SNR_TX	33.5	
R_LM	0.95	
N_qb	6	
P_qc	1.00E-07	

Operational			
ERL Pass threshold	11	dB	
COM Pass threshold	3	db	
DER_0	2.00E-04		
T_r	0.00400	ns	
FORCE_TR	1	logical	for legacy but required
PMD_type	C2C	for MMSE use C2C only	
EW	1		
MLSE	1	logical	
ts_anchor	1		
sample_adjustment	[-32 32]		
Local Search	0		
flim	6.70E+10	Hz	
zero_pad	1	logical	
Filter: Rx FFE			
ffe_pre_tap_len	**6**	UI	d_w
ffe_post_tap_len	8	UI	N_fix-d_w
ffe_pre_tap1_max	0.7	(normalized)	w_max(d_w) and -w_min(d_w)
ffe_post_tap1_max	0.7	(normalized)	w_max(d_w+2) and -w_min(d_w+2)
ffe_tapn_max	0.7	(normalized)	all other fixed w_max and w_min
num_ui_RXFF_noise	4096		
Floating Tap Control			
N_bg	**2**	0 1 2 or 3 groups	N_wg
N_bf	4	taps per group	N_wf
N_f	80	UI span for floating taps	Nmax-d_w-1
bmaxg	0.05	max FFE value for floating taps	all floating w_max and w_min
N_tail_start	9	(UI) start of tail taps limit	not supposed to be used but untested
TS_SRCH_MODE	full-sweep		

SAVE_CONFIG2MAT	0	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
ICN parameters		
T_t	6.000	ps
f_v	0.371	39.42
T_ft	4.250	ps
T_nt	4.250	ps
f_f	0.524	55.65
f_n	0.524	55.65
f_1	0.010	GHz
f_2	67.000	GHz
A_ft	0.600	V
A_nt	0.600	V

Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 5.95e-4 2.6e-05]*	1.4 db/in @ 53.125G
board_tl_tau	*5.790E-03*	ns/mm
board_Z_c	92.5	Ohm
z_bp (TX)	*9*	mm
z_bp (NEXT)	*9*	mm
z_bp (FEXT)	*9*	mm
z_bp (RX)	*9*	mm
C_0	[0 0]	nF
C_1	[0 0]	nF
Include PCB	**0**	**logical**

.START	PKG_LowR_CLASSA		
Parameter	**Setting**	**Units**	Information
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 ; 95 95 ; 100 100; 100 100]	Ohm	
R_d	[46.25 46.25]	Ohm	[TX RX]
z_p (TX)	[12 33 33 33 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
z_p (NEXT)	[12 33 33 33 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
z_p (FEXT)	[12 33 33 33 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
z_p (RX)	[12 33 33 33 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
C_p	[0.4e-4 0.4e-4]	nF	[TX RX]
A_v	0.385	V	Vf=0.400
A_fe	0.385	V	Vf=0.399
A_ne	0.481	V	Vf=0.400
.END			

COM Spreadsheet for Package Class B

data rate, die load, ref impedance			
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	[0.13 0.15 0.14; 0.13 0.15 0.14]	nH	[TX RX]
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]
R_0	46.25	Ohm	
PKG_NAME	**PKG_HiR_CLASSB PKG_HiR_CLASSB**		TX RX
z_p select	[3 4]		
L	4		
M	32		
filter and Eq			
f_r	0.55	*fb	
c(0)	0.55		min
c(-1)	0	[-0.34:.02:0]	[min:step:max]
c(-2)	0	[0.14:.02:0]	[min:step:max]
c(-3)	0		[min:step:max]
c(-4)	0		[min:step:max]
c(1)	0	[-0.2:.02:0]	[min:step:max]
N_b	1	UI	
b_max(1)	0.85		As/dffe1
b_max(2..N_b)	0		not used
b_min(1)	0		As/dffe1
b_min(2..N_b)	0	S	not used
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	42.50	GHz	
f_p1	42.50	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	1.328125	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\CAKR_{date}\	
SAVE_FIGURES	1	logical
Port Order	[1 3 2 4]	
RUNTAG	KR_pkgB_	
COM_CONTRIBUTION	0	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	ns
TR_TDR	0.005	
N	7000	logical
TDR_Butterworth	1	
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	0	UI
N_bx	15	??
fixture delay time	[0 0]	
Tukey_Window	1	
Z_t	46.25	
Noise, jitter		UI
sigma_RJ	0.01	UI
A_DD	0.02	V^2/GHz
eta_0	7.50E-09	dB
SNR_TX	33.5	
R_LM	0.95	
N_qb	6	
P_qc	1.00E-07	

Operational			
ERL Pass threshold	11	dB	
COM Pass threshold	3	db	
DER_0	2.00E-04		
T_r	0.00400	ns	
FORCE_TR	1	logical	
PMD_type	C2C		
EW	1		
MLSE	1	logical	
ts_anchor	1		
sample_adjustment	[-32 32]		
Local Search	0		
flim	6.70E+10	Hz	
zero_pad	1	logical	
Filter: Rx FFE			
ffe_pre_tap_len	**6**	UI	d_w
ffe_post_tap_len	8	UI	N_fix-d_w
ffe_pre_tap1_max	0.7	(normalized)	w_max(d_w) and -w_min(d_w)
ffe_post_tap1_max	0.7	(normalized)	w_max(d_w+2) and -w_min(d_w+2)
ffe_tapn_max	0.7	(normalized)	all other fixed w_max and w_min
num_ui_RXFF_noise	4096		
Floating Tap Control			
N_bg	**2**	0 1 2 or 3 groups	N_wg
N_bf	4	taps per group	N_wf
N_f	80	UI span for floating taps	Nmax-d_w-1
bmaxg	0.05	max FFE value for floating taps	all floating w_max and w_min
N_tail_start	9	(UI) start of tail taps limit	not supposed to be used but untested
TS_SRCH_MODE	full-sweep		

SAVE_CONFIG2MAT	0		
Receiver testing			
RX_CALIBRATION	0	logical	
Sigma BBN step	5.00E-03	V	
ICN parameters			
T_t	6.000	ps	
f_v	0.371	39.42	
T_ft	4.250	ps	
T_nt	4.250	ps	
f_f	0.524	55.65	
f_n	0.524	55.65	
f_1	0.010	GHz	
f_2	67.000	GHz	
A_ft	0.600	V	
A_nt	0.600	V	

Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 5.95e-4 2.6e-05]*	1.4 db/in @ 53.125G
board_tl_tau	*5.790E-03*	ns/mm
board_Z_c	92.5	Ohm
z_bp (TX)	*60*	mm
z_bp (NEXT)	*60*	mm
z_bp (FEXT)	*60*	mm
z_bp (RX)	*60*	mm
C_0	[0 0]	nF
C_1	[0 0]	nF
Include PCB	**0**	**logical**

.START	PKG_HiR_CLASSB		
Parameter	**Setting**	**Units**	Information
package_tl_gamma0_a1_a2	[0.0005 0.00065 0.000293]		
package_tl_tau	0.006141	ns/mm	
package_Z_c	[87.5 87.5 ; 95 95 ; 100 100; 78 78]	Ohm	
R_d	[46.25 46.25]	Ohm	[TX RX]
z_p (TX)	[8 24 30 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm	[test cases]
z_p (NEXT)	[8 24 29 44 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm	[test cases]
z_p (FEXT)	[8 24 30 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm	[test cases]
z_p (RX)	[8 24 29 44 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm	[test cases]
C_p	[0.4e-4 0.4e-4]	nF	[TX RX]
A_v	0.385	V	Vf=0.400
A_fe	0.385	V	Vf=0.399
A_ne	0.481	V	Vf=0.400
.END			