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Effect of TP0 to TP0v trace loss on dERL and dRpeak and proposal to tighten the dERL specification.

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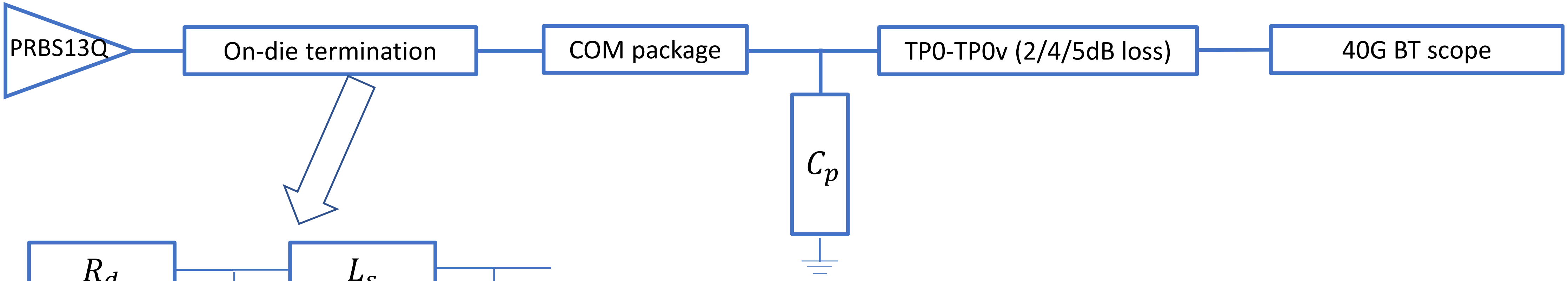
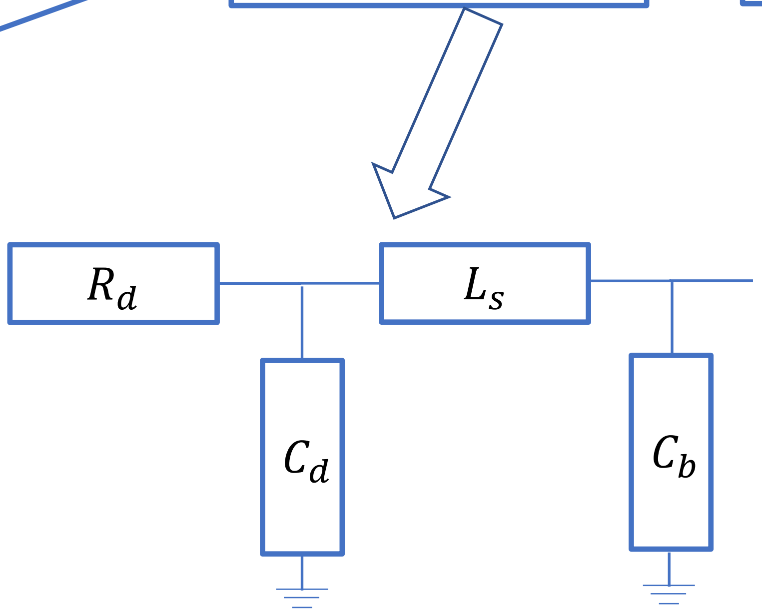
Introduction

- Having a variable loss between TP0 and TP0v is a new specification method in 802.3ck.
- This presentation explores how much the key parameters of dRpeak and dERL vary as a function of the TP0 to TP0v loss for the backplane specification.
- In order to obtain multiple different ASIC packages the value of Cp was swept while measuring dRpeak and dERL TP0 to TP0v losses of 2,4 and 5 dB were investigated.

- In the process of this evaluation it was noticed that for the 12mm package a large value of Cp still passed the transmitter specifications. The effect on COM of using these passing transmitters was evaluated on a backplane channel   (Kareti OAch1_t.s4p)

Linear pulse fit at TP0v simulation block diagram



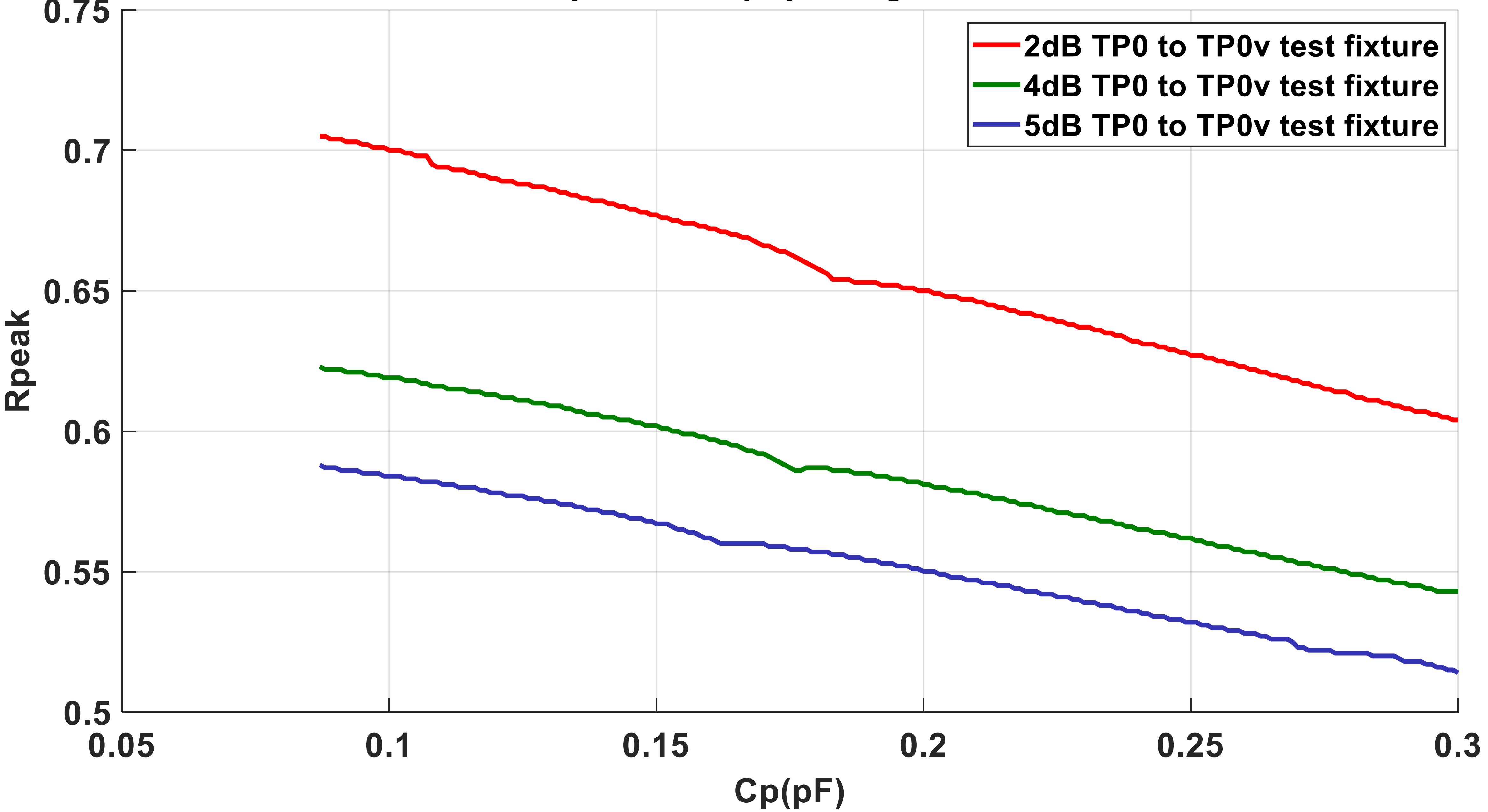


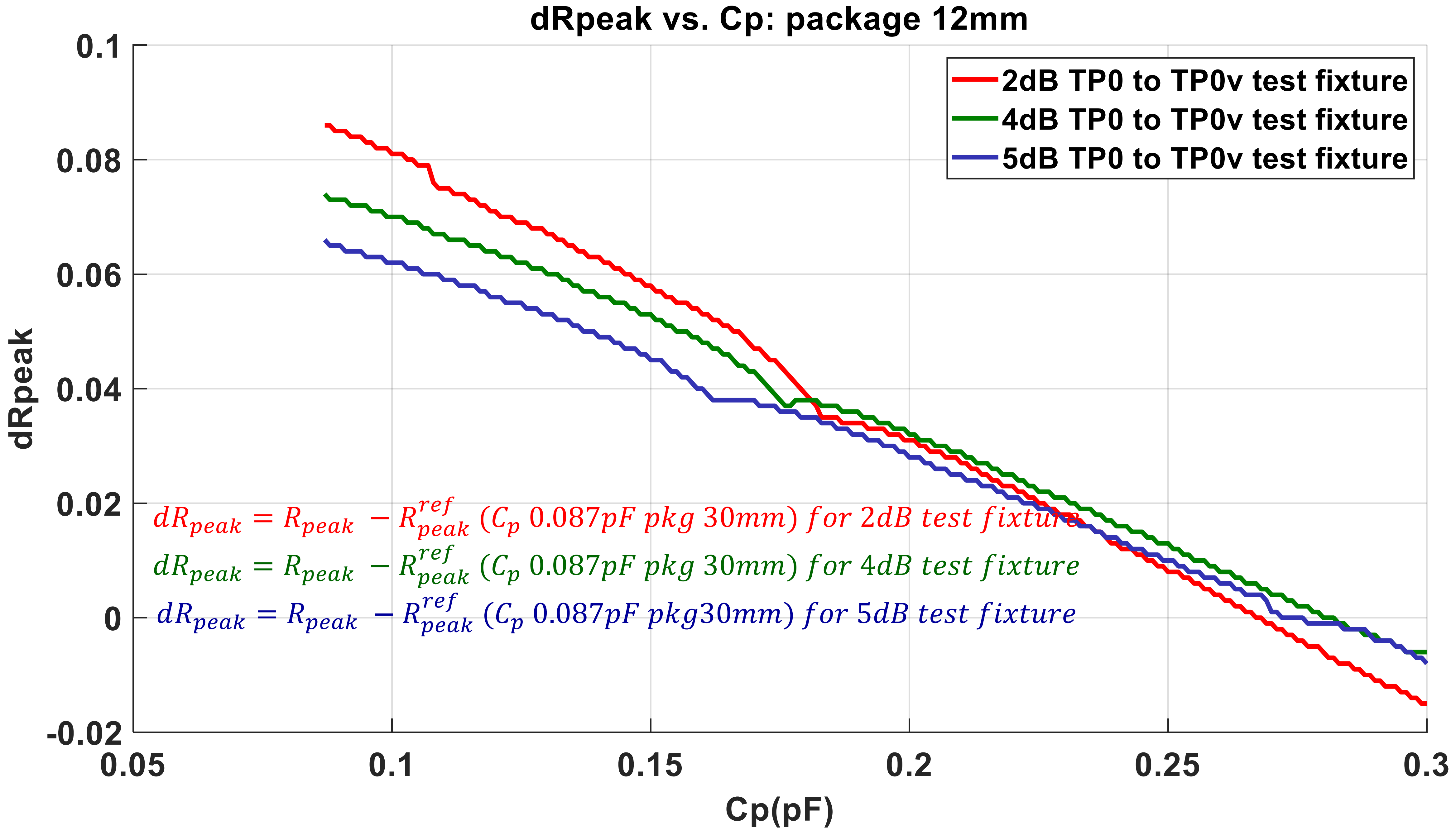
Package length: 12mm/30mm

Cd = 0.12pF
Ls = 120pH
Cb = 0.03pF
Cp = [0.087 to 0.3]pF

Np = 200
Dp = 4
Nv = 200

Rpeak vs. Cp: package 12mm




dRpeak vs. Cp: package 12mm
2dB TP0 to TP0v test fixture
4dB TP0 to TP0v test fixture
5dB TP0 to TP0v test fixture
$dR_{peak} = R_{peak} - R_{peak}^{ref}\ (C_p\ 0.087pF\ pkg\ 30mm)\ for\ 2dB\ test\ fixture$
$dR_{peak} = R_{peak} - R_{peak}^{ref}\ (C_p\ 0.087pF\ pkg\ 30mm)\ for\ 4dB\ test\ fixture$
$dR_{peak} = R_{peak} - R_{peak}^{ref}\ (C_p\ 0.087pF\ pkg30mm)\ for\ 5dB\ test\ fixture$
dRpeak
Cp(pF)
0.1
0.08
0.06
0.04
0.02
0
-0.02
0.05
0.1
0.15
0.2
0.25
0.3

Conclusions on dRpeak.

- The use of dRpeak provides a specification that is reasonably independent of the Tp0 to TP0v test trace loss particularly at the critical specification point (dRpeak =0) where the variation is less than 0.01.
- For the 12mm package a value of Cp up to over 0.25pF passed the dRpeak specification.

ERL at TP0V simulation block diagram

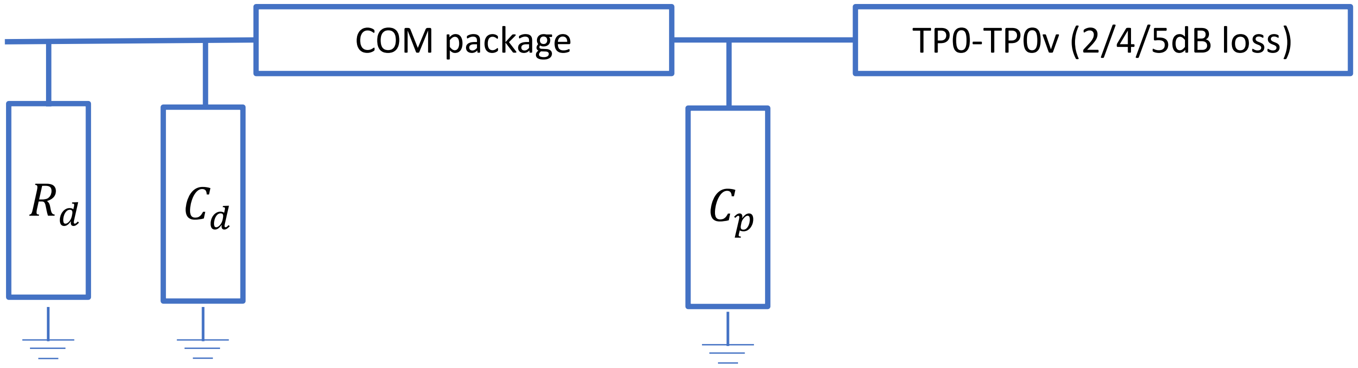


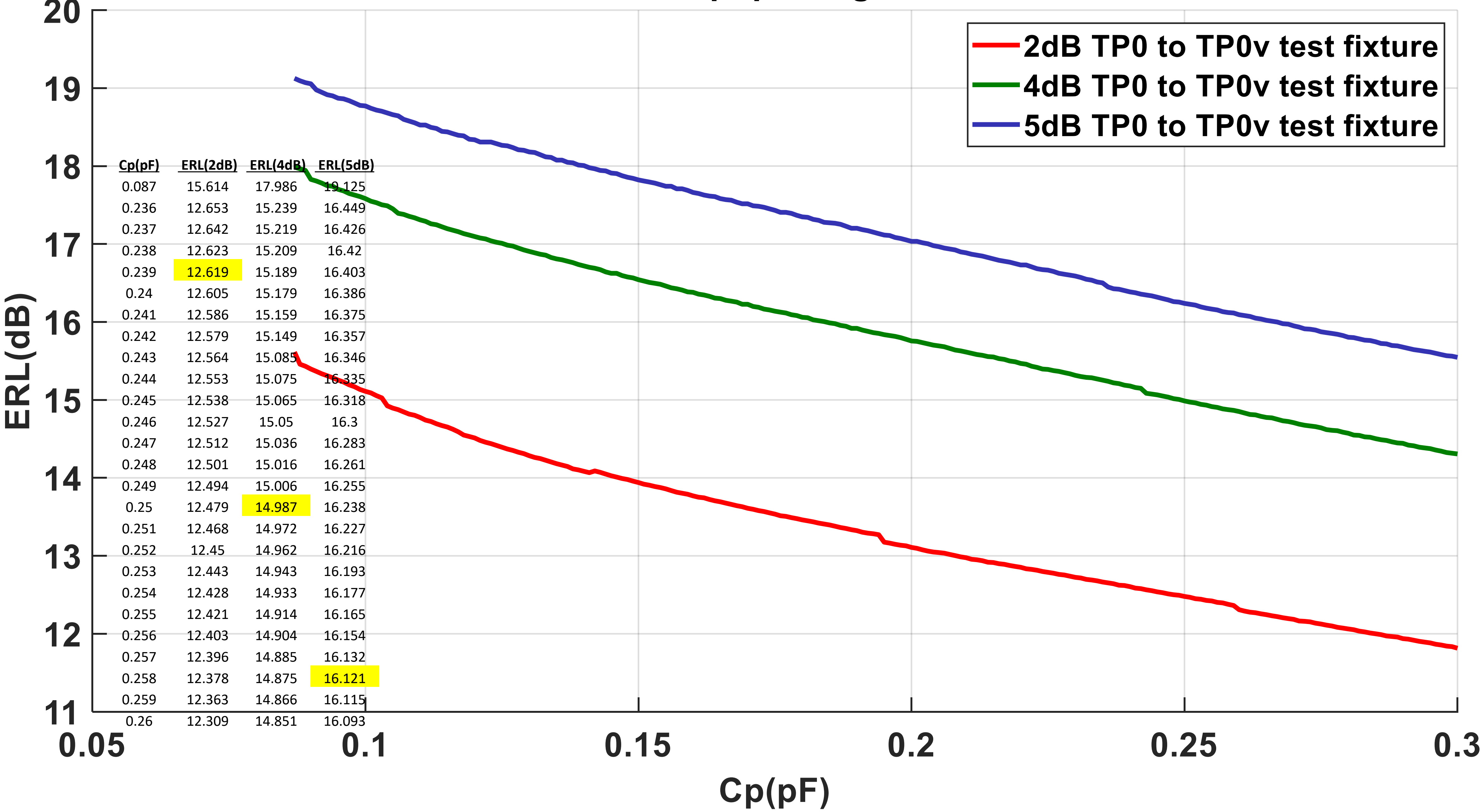
Table 163–7—Transmitter and receiver ERL parameter values

Parameter	Symbol	Value	Units
Transition time associated with a pulse	T_r	0.01	ns
Incremental available signal loss factor	β_x	0	GHz
Permitted reflection from a transmission line external to the device under test	ρ_x	0.618	—
Length of the reflection signal	N	200	UI
Equalizer length associated with reflection signal	N_{bx}	21	UI
Tukey window flag	tw	1	—

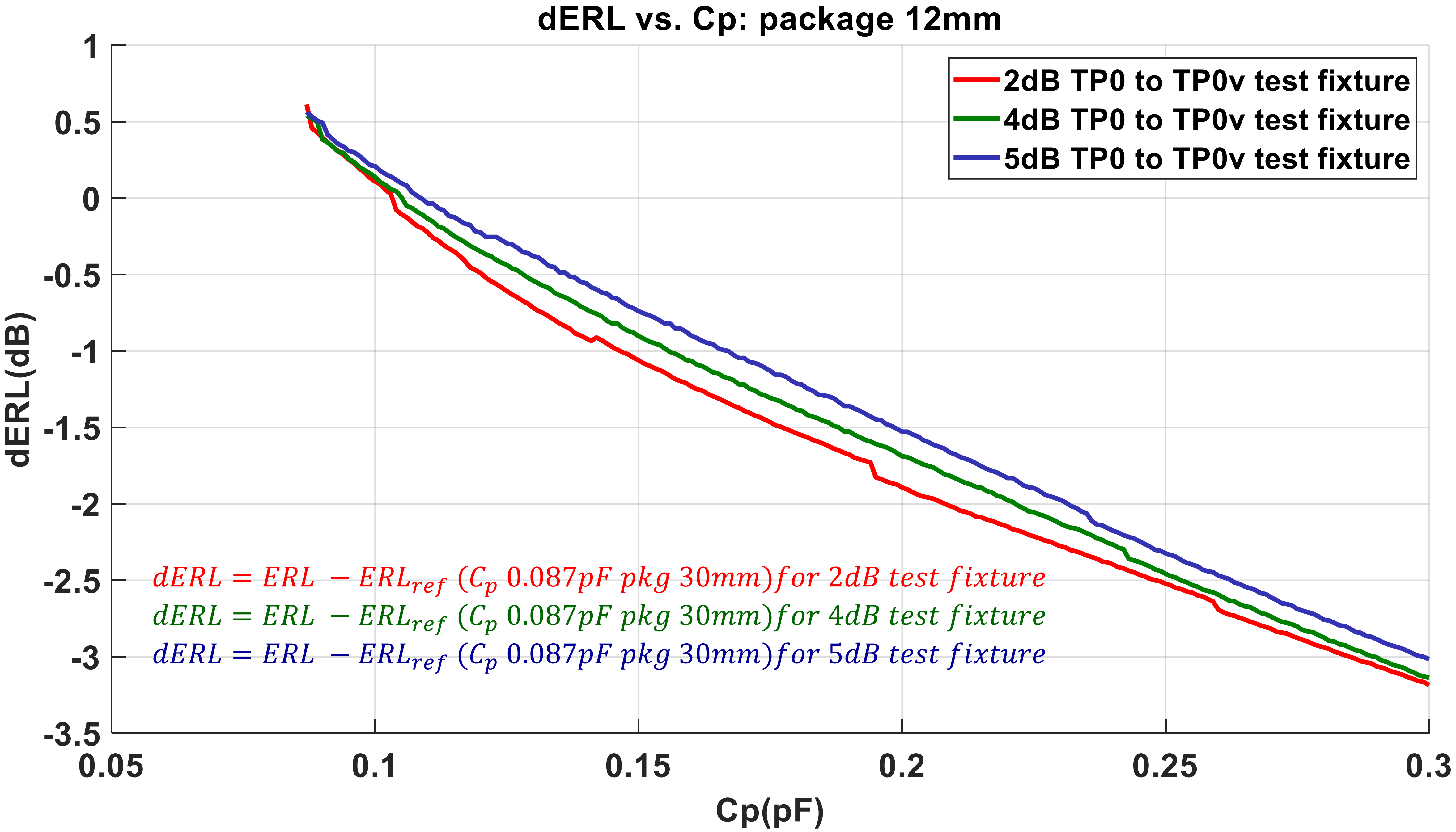
The value of T_{fx} is twice the delay from TP0 to TP0v

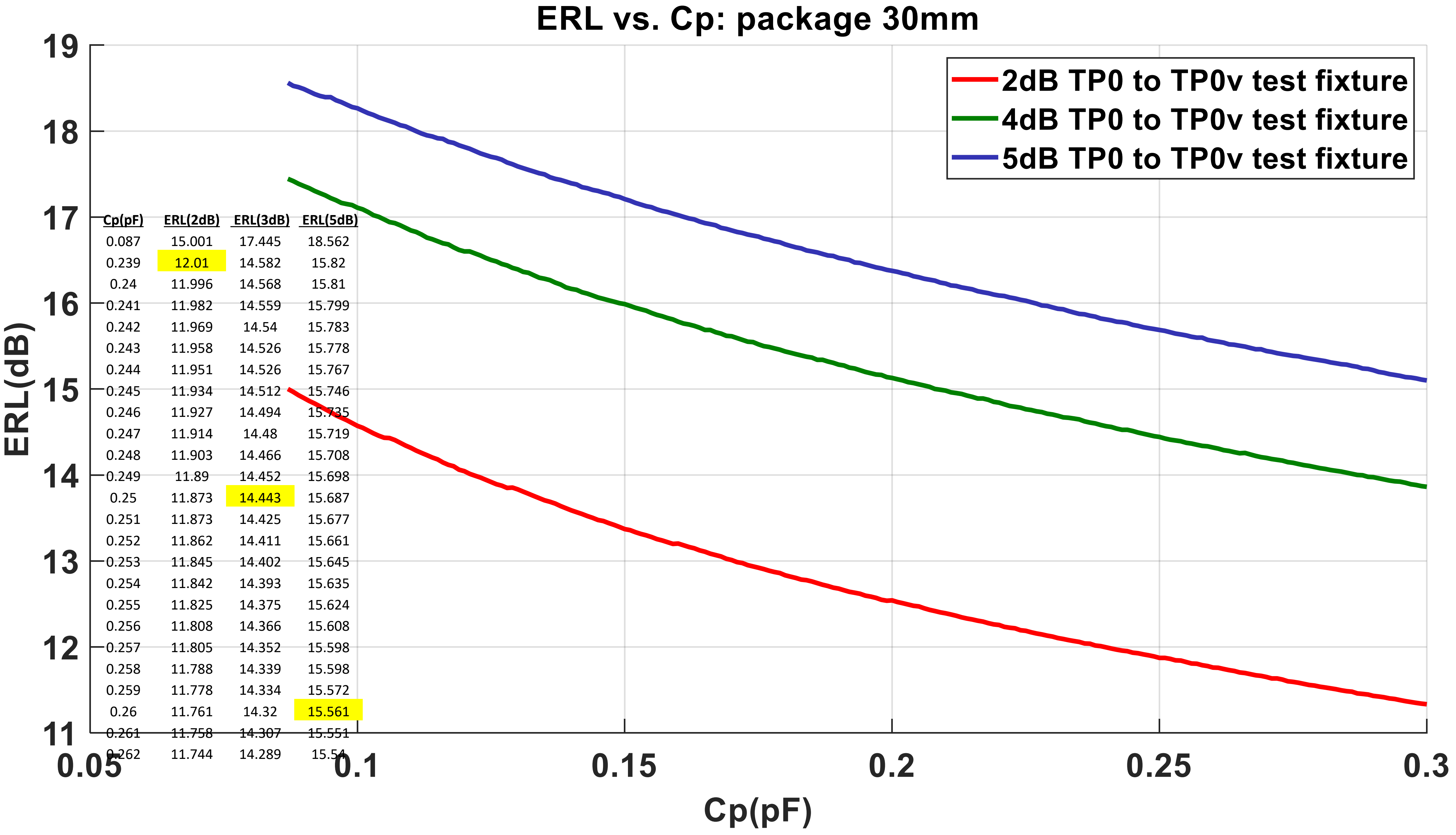
Package length: 12mm/30mm
Rd = 50ohm
Cd = 0.12pF
Cp = [0.087:0.001:0.3]pF

ERL vs. Cp: package 12mm

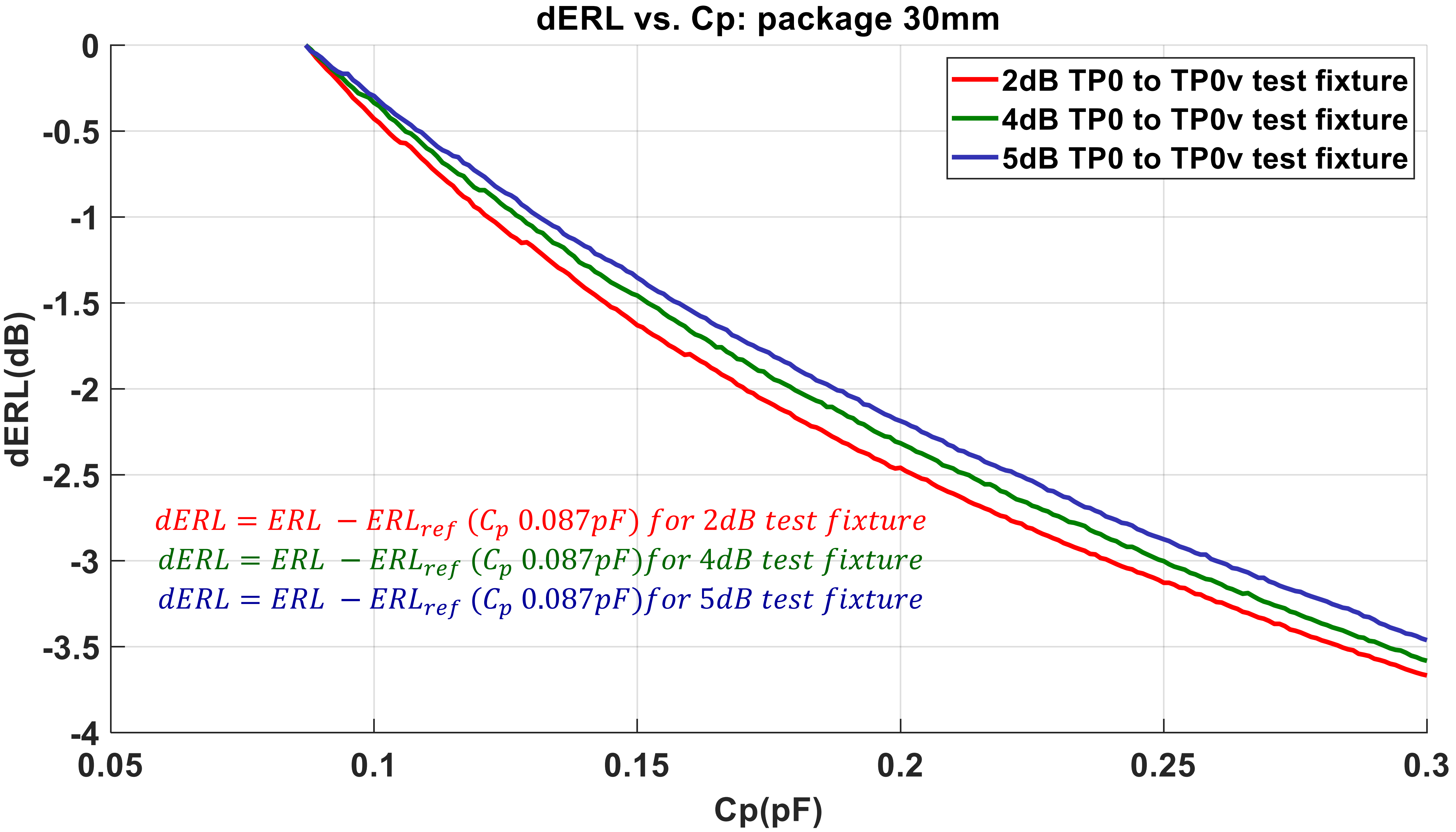


Cp(pF)	ERL(2dB)	ERL(4dB)	ERL(5dB)
0.087	15.614	17.986	19.125
0.236	12.653	15.239	16.449
0.237	12.642	15.219	16.426
0.238	12.623	15.209	16.42
0.239	12.619	15.189	16.403
0.24	12.605	15.179	16.386
0.241	12.586	15.159	16.375
0.242	12.579	15.149	16.357
0.243	12.564	15.085	16.346
0.244	12.553	15.075	16.335
0.245	12.538	15.065	16.318
0.246	12.527	15.05	16.3
0.247	12.512	15.036	16.283
0.248	12.501	15.016	16.261
0.249	12.494	15.006	16.255
0.25	12.479	14.987	16.238
0.251	12.468	14.972	16.227
0.252	12.45	14.962	16.216
0.253	12.443	14.943	16.193
0.254	12.428	14.933	16.177
0.255	12.421	14.914	16.165
0.256	12.403	14.904	16.154
0.257	12.396	14.885	16.132
0.258	12.378	14.875	16.121
0.259	12.363	14.866	16.115
0.26	12.309	14.851	16.093


dERL vs. Cp: package 12mm
2dB TP0 to TP0v test fixture
4dB TP0 to TP0v test fixture
5dB TP0 to TP0v test fixture
dERL(dB)
Cp(pF)
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
0.05
0.1
0.15
0.2
0.25
0.3
dERL = ERL − ERL_ref (C_p 0.087pF pkg 30mm) for 2dB test fixture
dERL = ERL − ERL_ref (C_p 0.087pF pkg 30mm) for 4dB test fixture
dERL = ERL − ERL_ref (C_p 0.087pF pkg 30mm) for 5dB test fixture



Cp(pF)	ERL(2dB)	ERL(3dB)	ERL(5dB)
0.087	15.001	17.445	18.562
0.239	12.01	14.582	15.82
0.24	11.996	14.568	15.81
0.241	11.982	14.559	15.799
0.242	11.969	14.54	15.783
0.243	11.958	14.526	15.778
0.244	11.951	14.526	15.767
0.245	11.934	14.512	15.746
0.246	11.927	14.494	15.735
0.247	11.914	14.48	15.719
0.248	11.903	14.466	15.708
0.249	11.89	14.452	15.698
0.25	11.873	14.443	15.687
0.251	11.873	14.425	15.677
0.252	11.862	14.411	15.661
0.253	11.845	14.402	15.645
0.254	11.842	14.393	15.635
0.255	11.825	14.375	15.624
0.256	11.808	14.366	15.608
0.257	11.805	14.352	15.598
0.258	11.788	14.339	15.598
0.259	11.778	14.334	15.572
0.26	11.761	14.32	15.561
0.261	11.758	14.307	15.551
0.262	11.744	14.289	15.54


dERL vs. Cp: package 30mm
2dB TP0 to TP0v test fixture
4dB TP0 to TP0v test fixture
5dB TP0 to TP0v test fixture
dERL(dB)
Cp(pF)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
0.05
0.1
0.15
0.2
0.25
0.3
$dERL = ERL - ERL_{ref}\ (C_p\ 0.087pF)\ for\ 2dB\ test\ fixture$
$dERL = ERL - ERL_{ref}\ (C_p\ 0.087pF) for\ 4dB\ test\ fixture$
$dERL = ERL - ERL_{ref}\ (C_p\ 0.087pF) for\ 5dB\ test\ fixture$

Conclusions on dERL.

- The use of dERL provides a specification that is reasonably independent of the Tp0 to TP0v test trace loss with a variability of less than 0.5dB.
- For the 12mm package a value of Cp up to 0.267pF passed the dERL specification of -3dB.
- With the large values of Cp that are passing dERL and dRpeak the effect on the channel performance was investigated.

OAch1_t.s4p (IL=23.407dB, ERL11=13.706dB, ERL22=16.973dB)

9 FEXT and 9 NEXT included

TX Package(mm)	TX Cp(pF)	2dB TP0-TP0v		4dB TP0-TP0v		5dB TP0-TP0v		IL w/pkg(dB)	COM(dB)
		dERL(dB)	dRpeak(dB)	dERL(dB)	dRpeak(dB)	dERL(dB)	dRpeak(dB)		
30	0.087	0	0	0	0	0	0	31.714	3.986
	0.107	-0.034	-0.006	-0.026	-0.002	-0.036	-0.004	31.921	3.849
12	0.087	0.613	0.086	0.541	0.074	0.563	0.066	30.066	4.437
	0.107	-0.155	0.079	-0.065	0.068	0.037	0.06	30.381	4.265
	0.127	-0.649	0.068	-0.472	0.061	-0.325	0.054	30.734	4.194
	0.147	-1.009	0.059	-0.85	0.054	-0.686	0.047	31.114	4.082
	0.167	-1.341	0.05	-1.178	0.044	-1	0.038	31.513	3.836
	0.187	-1.638	0.034	-1.489	0.036	-1.309	0.033	31.923	3.795
	0.207	-1.983	0.028	-1.784	0.03	-1.626	0.026	32.338	3.622
	0.227	-2.239	0.019	-2.079	0.022	-1.938	0.019	32.754	3.388
	0.247	-2.489	0.01	-2.409	0.014	-2.279	0.011	33.167	3.173
	0.267	-2.781	0	-2.694	0.006	-2.563	0.004	33.575	3.135
	0.287	-3.029	-0.009	-2.965	-0.002	-2.843	-0.002	33.975	2.95
	0.299	-3.166	-0.015	-3.129	-0.006	-3.001	-0.007	34.212	2.793

Red results are transmitters that fail 802.3ck draft 2.0.

All others pass with at least one Tp0 to Tp0v test fixture..

Conclusions on COM results and existing Tx specifications.

- With the existing Tx specifications of dERL and dRpeak the combination of the Tx and a channel can have 0.85dB worse COM than the channel COM result resulting in a potential inter-operability problem. This is even with a channel with significant margin to ERL (13.7dB versus a specification of 9.7dB).
- The dERL specification should be tightened. Based on these results a value of -1dB seems appropriate as this results in a COM that is similar to the channel COM.
- Further work should be performed to check the performance with channels with ERL closer to specification to verify whether an even tighter value of dERL is needed.

Backup

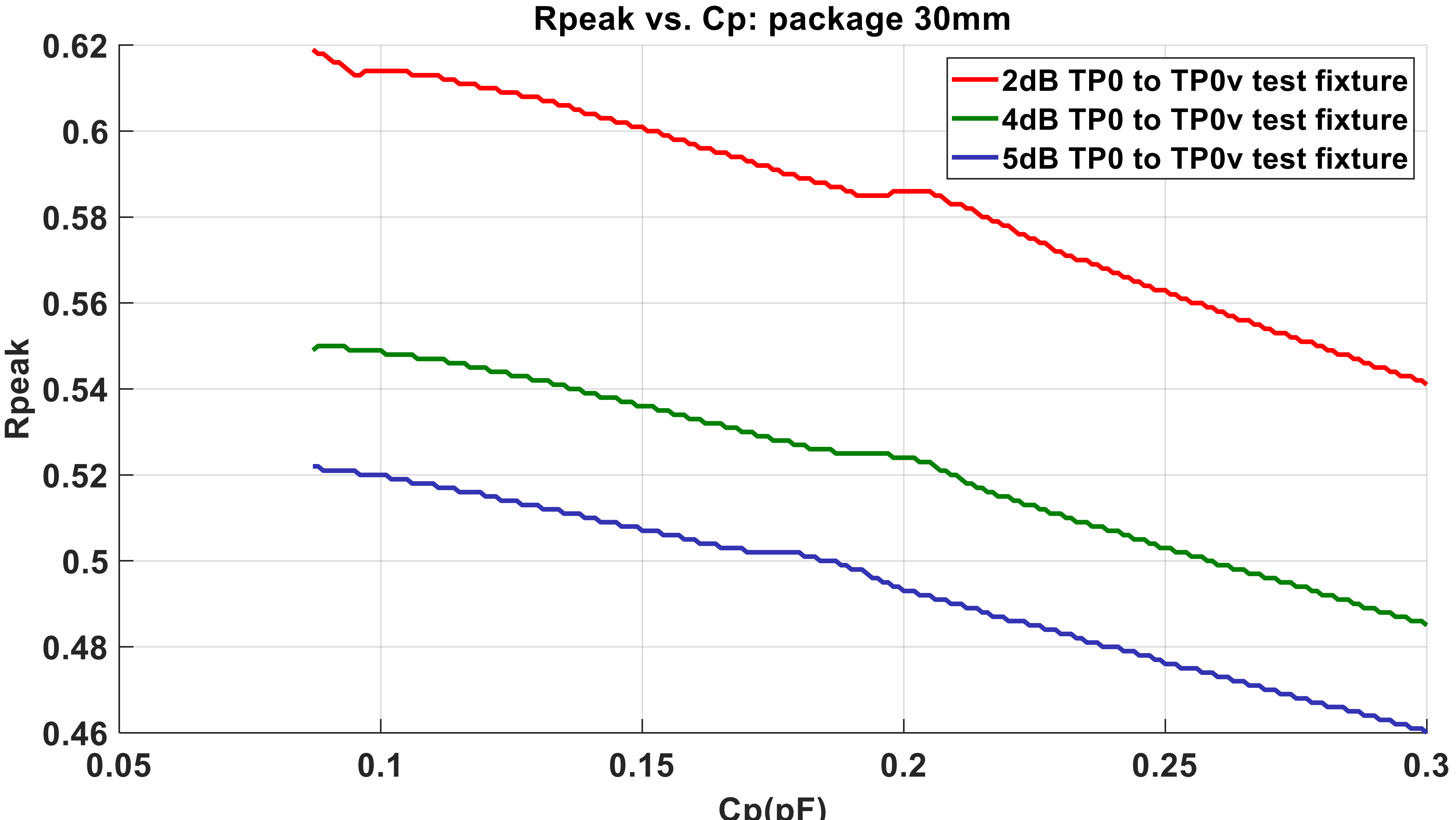
COM spreadsheet

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 1.2e-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)	[12 30; 1.8 1.8]	mm	[test cases]	
z_p (NEXT)	[30 30; 1.8 1.8]	mm	[test cases]	
z_p (FEXT)	[12 30; 1.8 1.8]	mm	[test cases]	
z_p (RX)	[30 30; 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		
A_fe	0.413	V		
A_ne	0.608	V		
AC_CM_RMS	0	V	[test cases]	[0.0235 0.0256]
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)	[-0.2:0.05:0]		[min:step:max]	
N_b	12	UI		
b_max(1)	0.85			
b_max(2..N_b)	[0.3 0.2*ones(1,10)]			
b_min(1)	0.3			
b_min(2..N_b)	[0.05 -0.03*ones(1,10)]			
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		

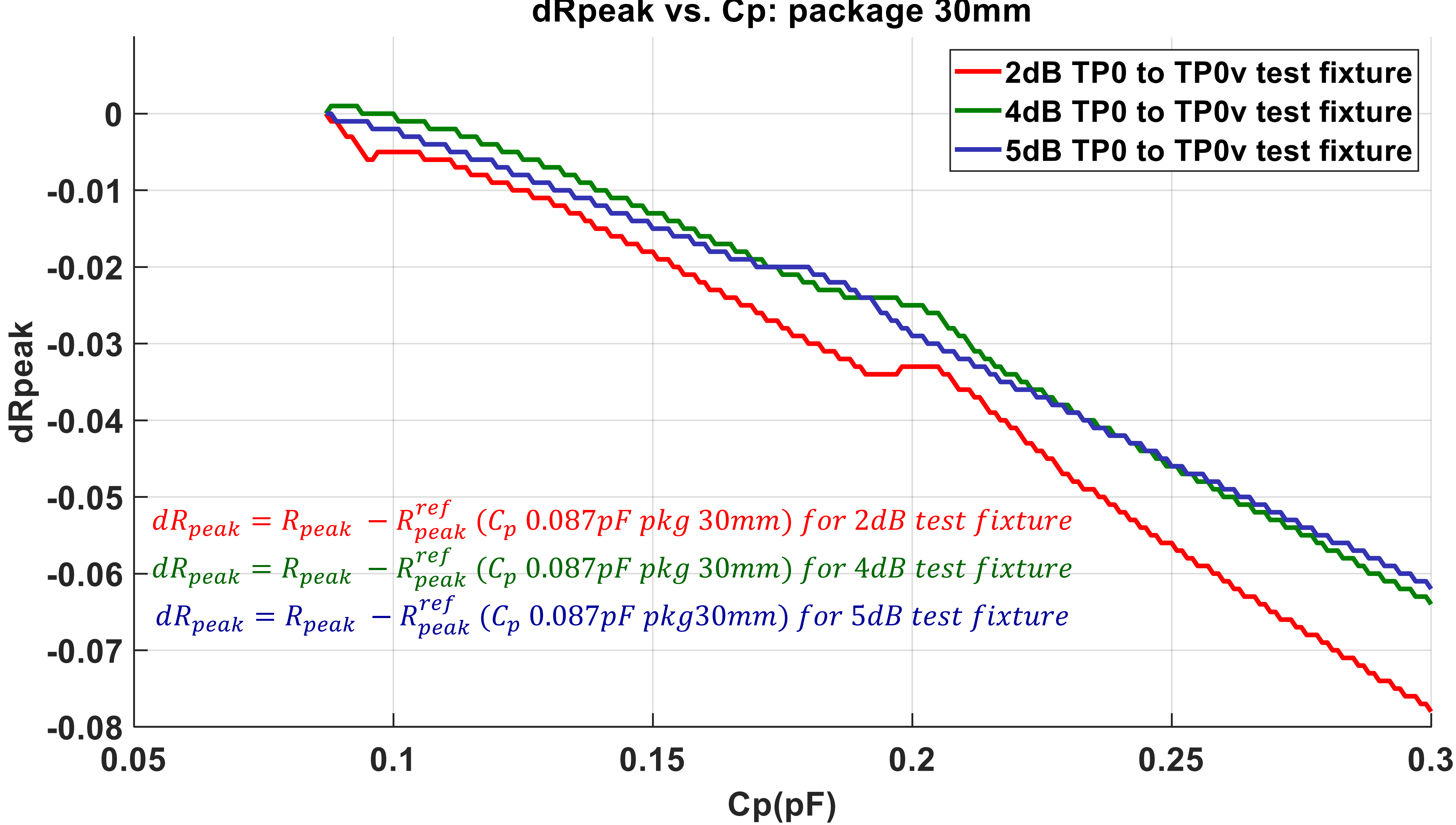
I/O control		
DIAGNOSTICS	0	logical
DISPLAY_WINDOW	0	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\100GEL_KR_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	KR_eval_	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	8	dB
DER_0	0.0001	
T_r	0.0075	ns
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	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	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	3	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	40	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	25	(UI) start of tail taps limit
ICN & FOM_ILD parameters		
f_v	0.594	*Fb
f_f	0.594	*Fb
f_n	0.594	*Fb
f_2	40.000	GHz
A_ft	0.600	V
A_nt	**0.600**	V
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
new		

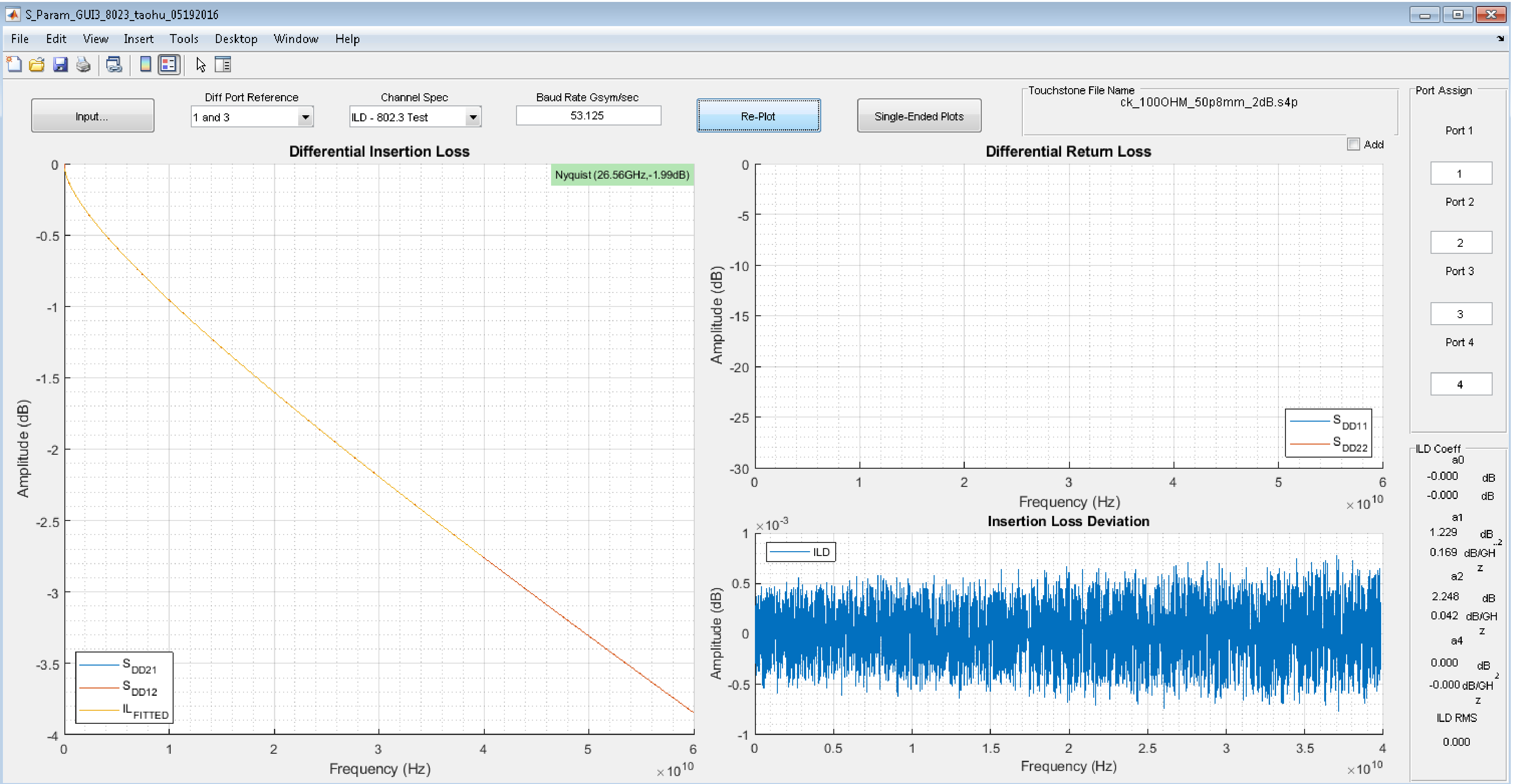
RX: 30mm package and 0.087pF Cp



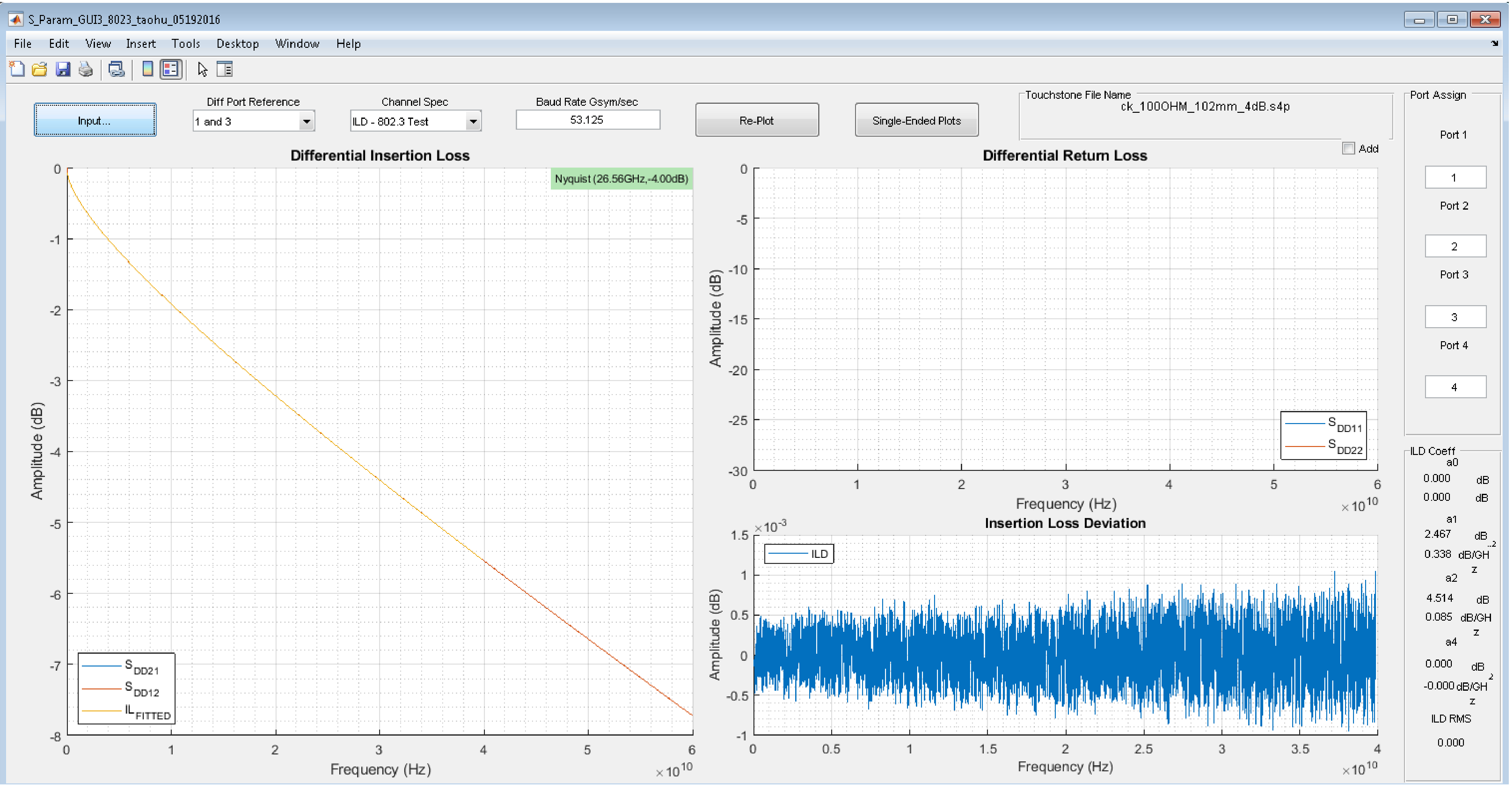
Rpeak vs. Cp: package 30mm
2dB TP0 to TP0v test fixture
4dB TP0 to TP0v test fixture
5dB TP0 to TP0v test fixture
Rpeak
Cp(pF)
0.62
0.6
0.58
0.56
0.54
0.52
0.5
0.48
0.46
0.05
0.1
0.15
0.2
0.25
0.3


dRpeak vs. Cp: package 30mm
2dB TP0 to TP0v test fixture
4dB TP0 to TP0v test fixture
5dB TP0 to TP0v test fixture
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
dRpeak
0.05
0.1
0.15
0.2
0.25
0.3
Cp(pF)
$dR_{peak} = R_{peak} - R_{peak}^{ref}\ (C_p\ 0.087pF\ pkg\ 30mm)\ for\ 2dB\ test\ fixture$
$dR_{peak} = R_{peak} - R_{peak}^{ref}\ (C_p\ 0.087pF\ pkg\ 30mm)\ for\ 4dB\ test\ fixture$
$dR_{peak} = R_{peak} - R_{peak}^{ref}\ (C_p\ 0.087pF\ pkg30mm)\ for\ 5dB\ test\ fixture$

2dB TP0-TP0v test fixture



4dB TP0-TP0v test fixture



5dB TP0-TP0v test fixture