S-Parameter Stop Frequency Impact on COM and ERL for CR/KR and C2M Channels

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Unresolved D1.3 comment Reference# 47

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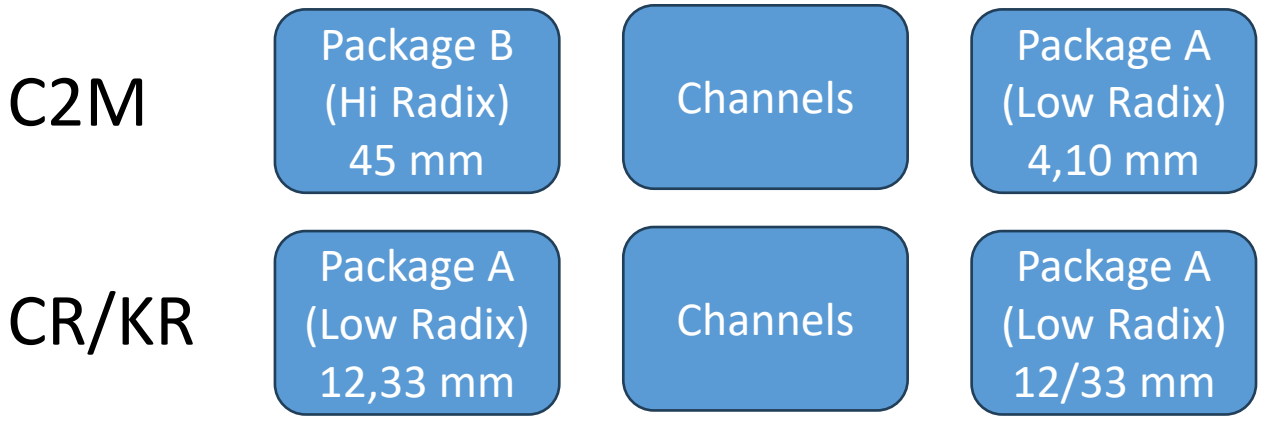
Purpose – Considerations for D2.0 Comments

- Evaluate the impact of s-parameter frequency range on COM and ERL computations
- Address Unresolved D1.3 comment Reference# 47
  - https://www.ieee802.org/3/dj/public/25_03/mellitz_3dj_01_2503.pdf
  - Same presentation with some added data

Process

- Compute COM for a collection of posted s-parameter channel files
  - COM 4.8beta3 was modified to limit s-parameters stop frequency using a parameter called “flim”
- Channels were used where s-parameter channels stop frequency were greater than or equal to 100 GHz
  - C2M configuration parameter were based .3dj D1.3
  - CR/KR configuration parameter were based .3dj D1.3
- Compute COM using flim set to 67, 80, 85, 90, and greater than 100 GHz
- Compute delta COM and delta ERL
  - ΔCOM = COM(flim >100 GHz) – COM(flim)
  - ΔERL = COM(ERL > 100 GHz) – ERL(flim)

COM setup



- Since this is an existence proof, only the above configurations were utilized
  - Many more are possible
- C2M COM Parameters were taken from d1.4 Annex 176D.6.2 (COM reference model) with Tx FFE turned off.
- CR/KR COM Parameters were taken from d1.4 178.10.1 (COM reference model) with Tx FFE turned off.
- COM configurtaions are at end

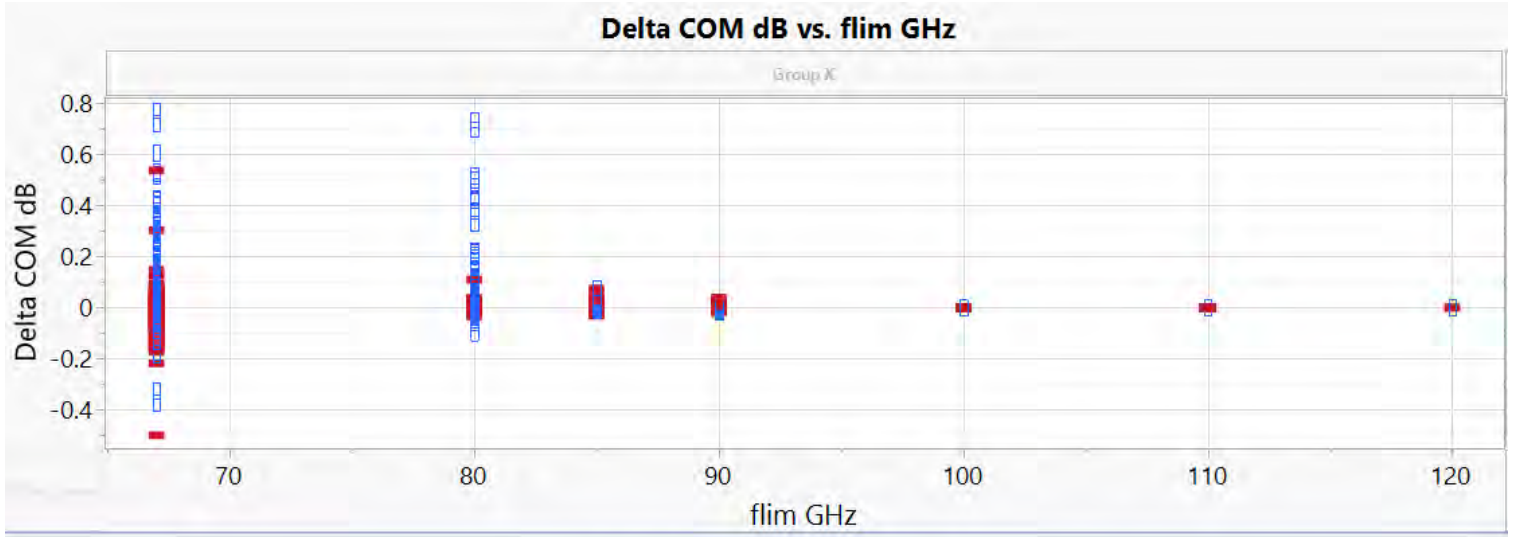
C2M Channel Contribution List (220 Channels)

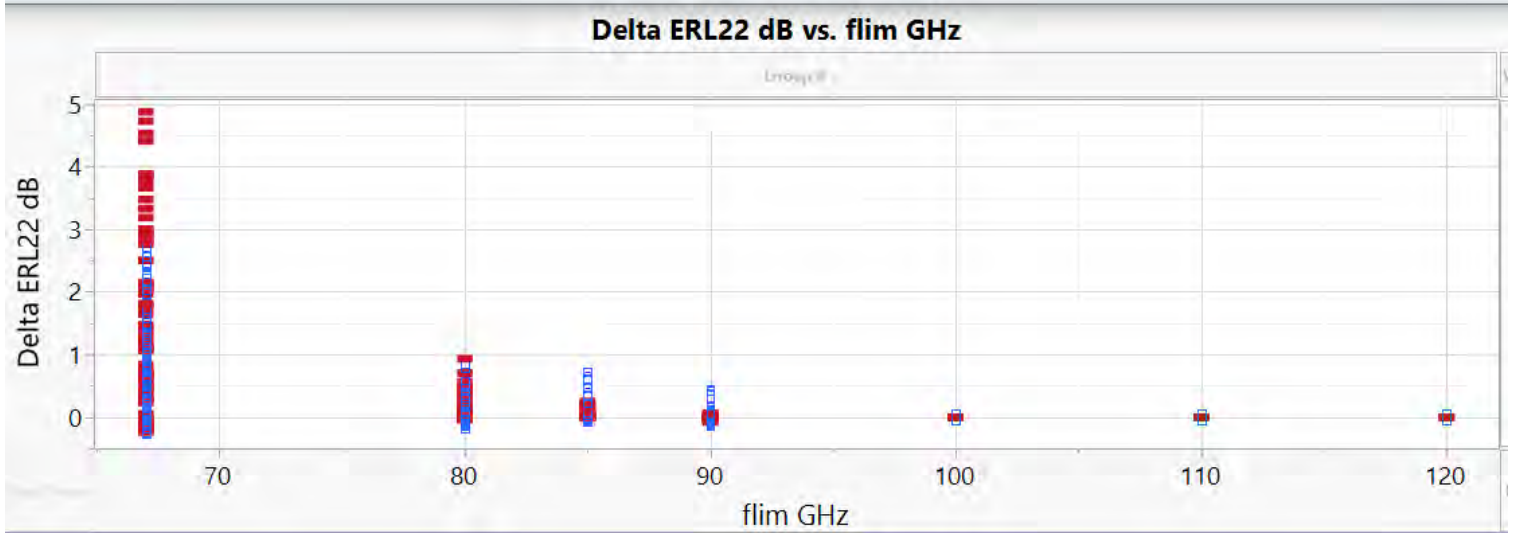
- akinwale_3df_01_2307
- gore_3dj_elec_02_231026a
- kareti_3dj_02_2309
- kareti_3dj_elec_02_240111
- rabinovich_3dj_01_230116
- weaver_3dj_elec_02_230831
- sekel_3dj_02_2407

CR Channel Contribution List (91 Channels)

- akinwale_3dj_01_2311
- kocsis_3dj_02_2305
- lim_3dj_03n04_2306205
- mellitz_3dj_02_elec_230504
- weaver_3dj_02_2303
- weaver_3dj_02_2305
- weaver_3dj_02_2311
- weaver_3dj_elec_01_230622
- weaver_3dj_elec_01_230622a

Snapshot: ΔCOM and ΔERL vs. flim



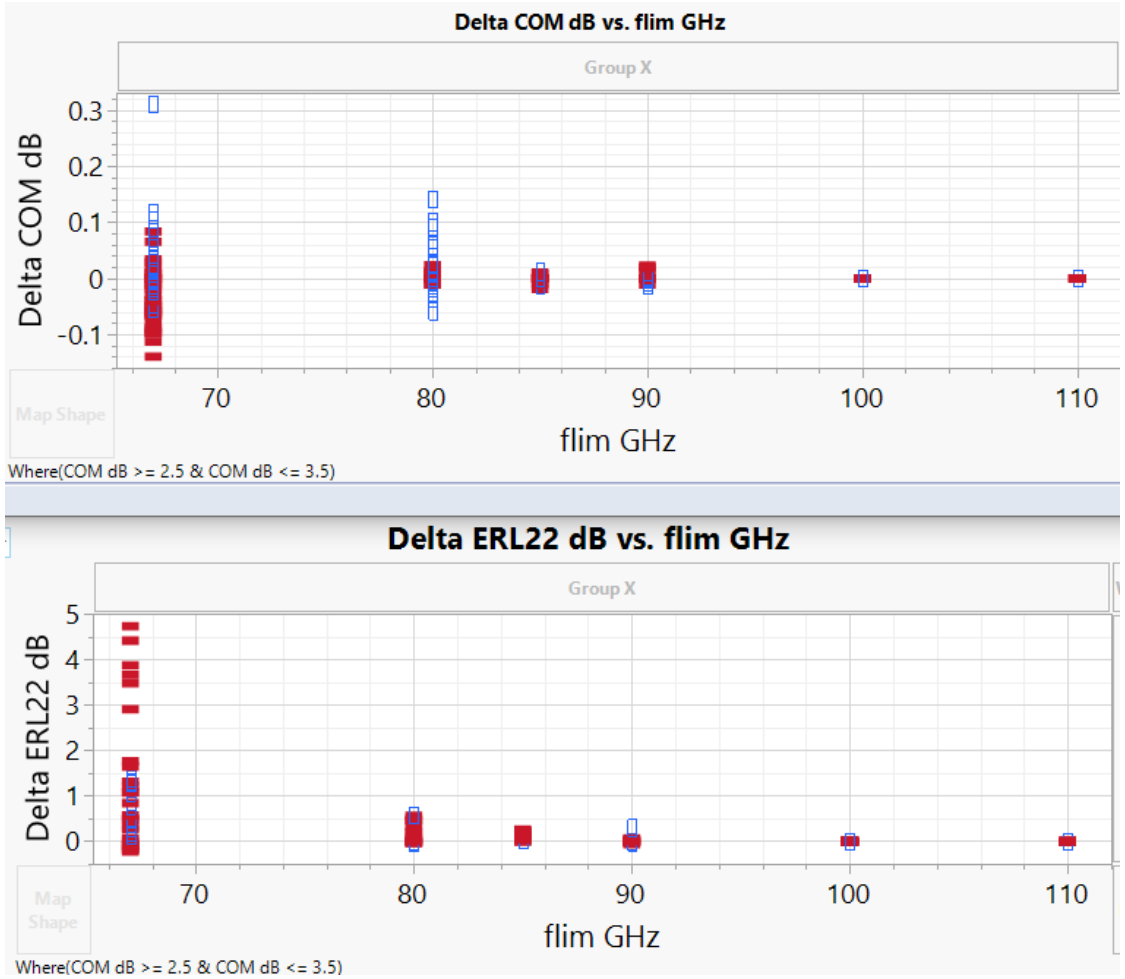


- The s-parameter stop frequency (flim) to 67 GHz may have a impact on ΔCOM and ΔERL
- Setting flim to 80 GHz does not appear to be high enough to significantly tighten the limits ΔCOM
- CR/KR channel had less variation
- What if COM is between 2.5 and 3.5 dB?

RED marker – CR/KR
BLUE marker -C2M

Snapshot: ΔCOM and ΔERL vs. flim

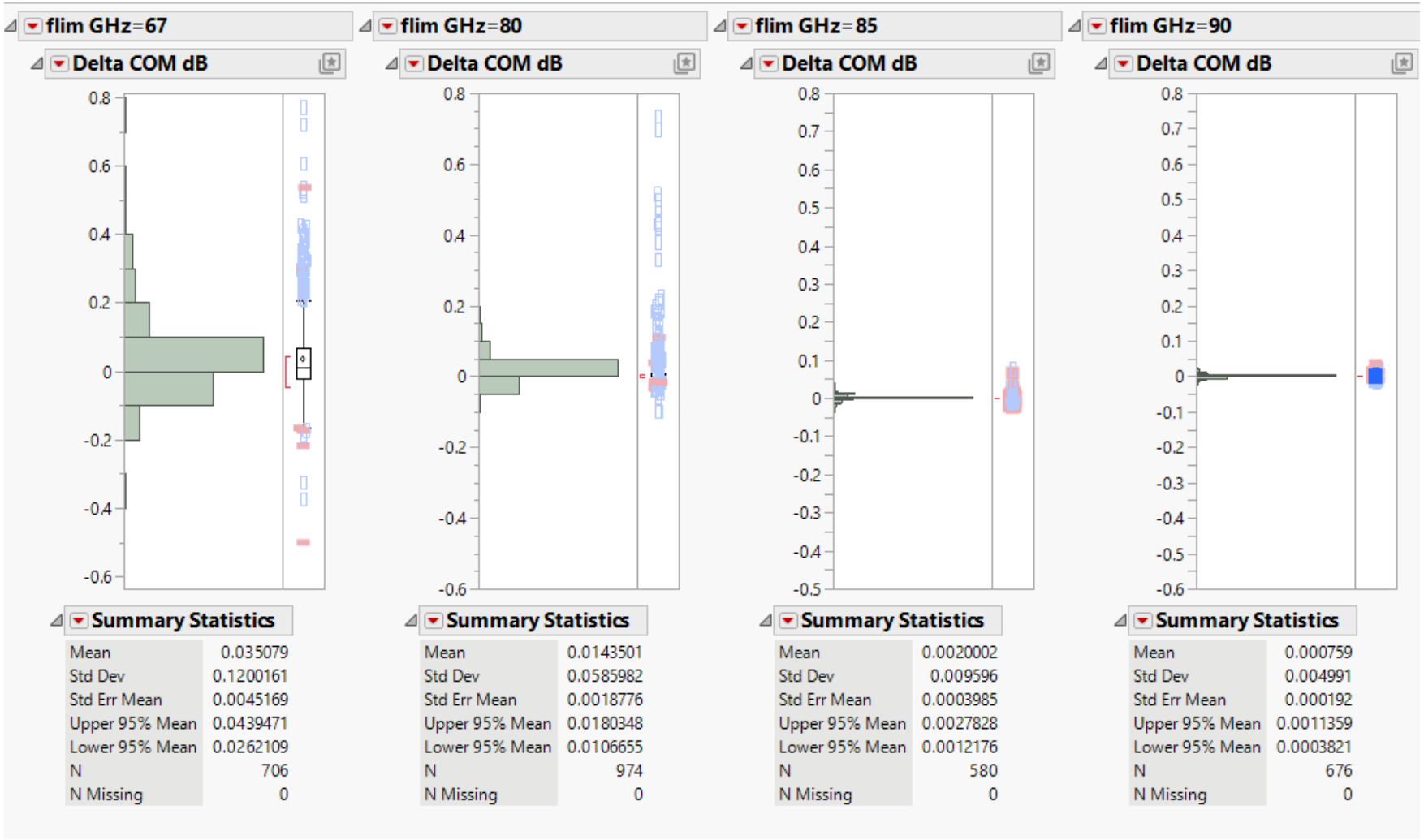
COM between 2.5 dB and 4 dB



- Less a ΔCOM variation is evident for channel between 2.5 and 4 dB
- ΔERL is variation is still significant using flim at 67 GHz

RED marker – CR/KR
BLUE marker -C2M

ΔCOM vs. Stop Frequency (flim)



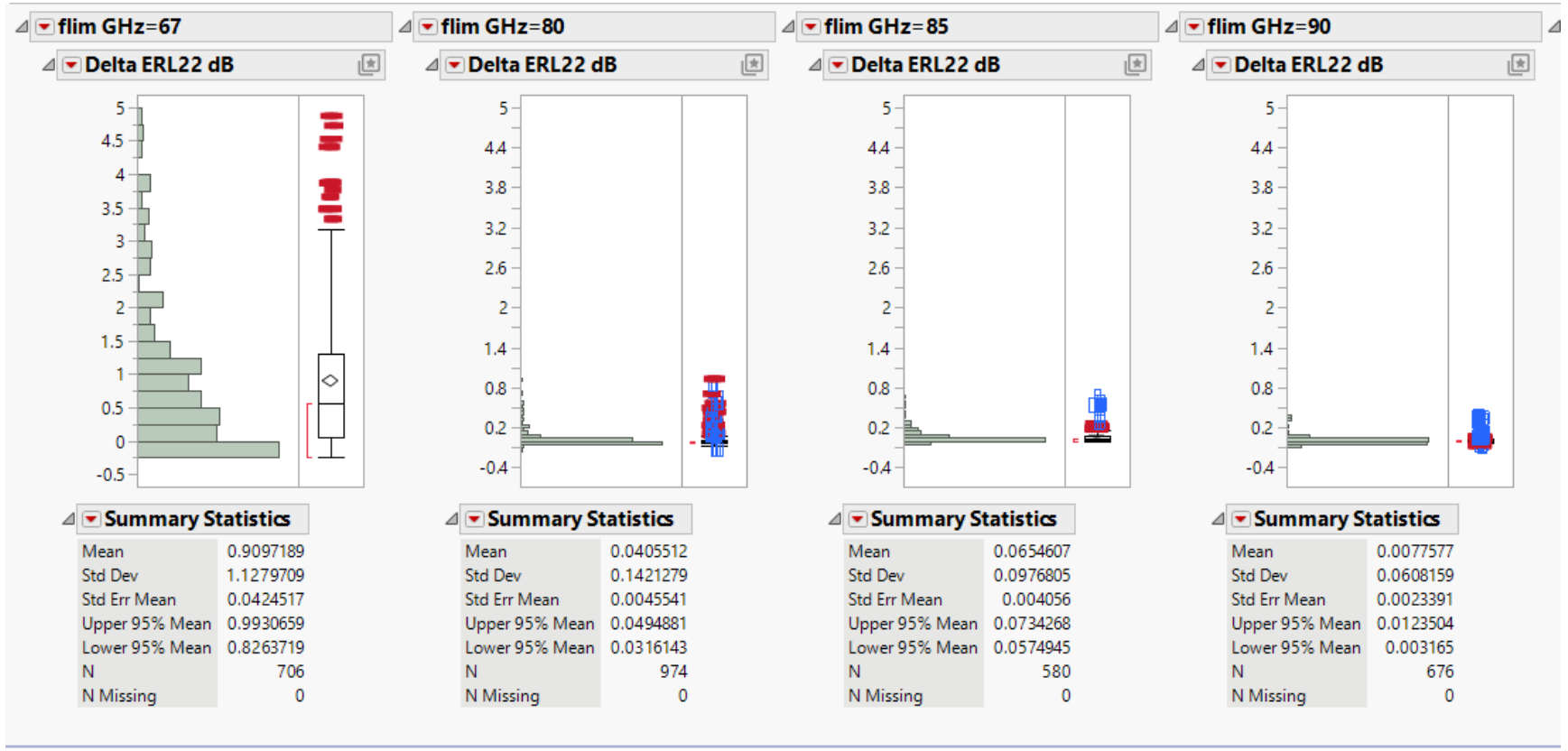
- Most of the time delta com is small when flim is 67 GHz

ΔCOM vs. Stop Frequency (flim)

COM between 2.5 dB and 3.5 dB

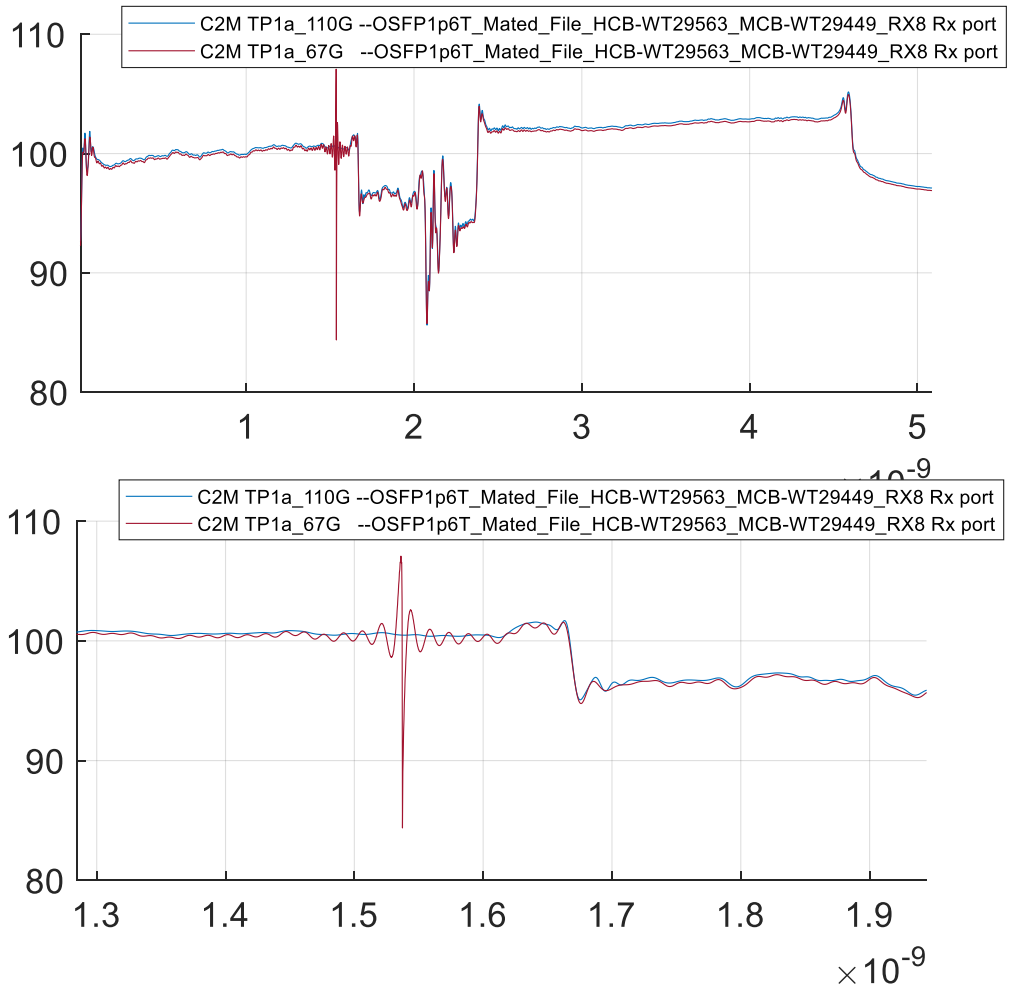
- ΔCOM is cut by about ½ when COM is between 2.5 dB and 3.5 dB

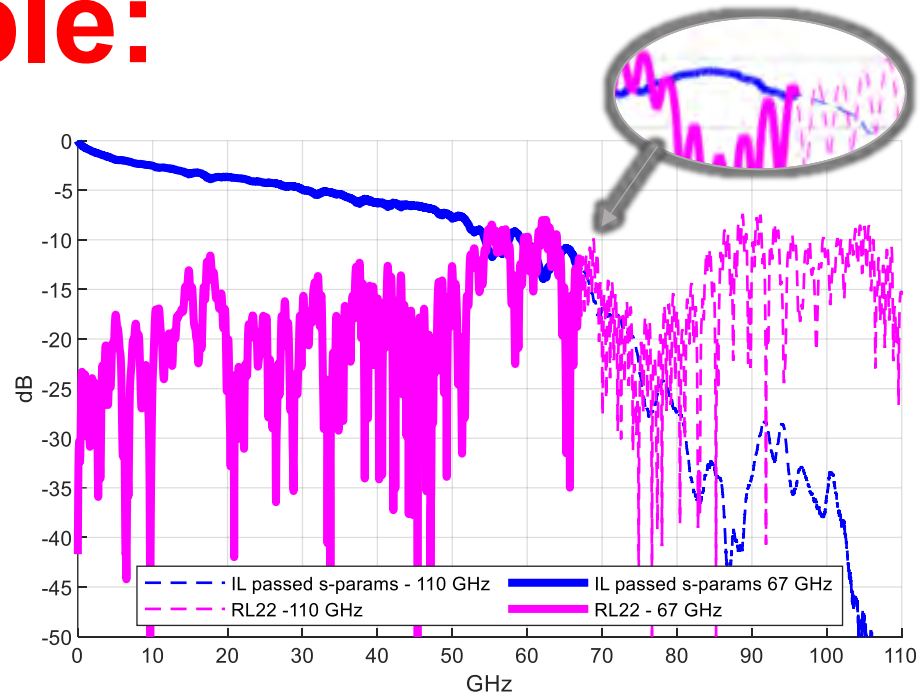
ΔERL vs. Stop Frequency (flim)



- ΔERL is affected by flim more than ΔCOM

Outlier Case Example:





- ERL impact can greater than COM for a limited stop frequency range.
- TDR example illustrates phantom alias around 1.5 ns
- Making up data after the stop frequency can be challenging and not specified in the standard
  - Sloping up .. Sloping down … in hole???

Options

- Option A: Change 178A.1.3

  It is recommended that the scattering parameters be measured with a uniform frequency step from a start frequency no greater than 10 MHz to a stop frequency of at least 67 GHz. The measurement frequency step corresponds to the time span of the pulse response derived from the S- parameters (see 178A.1.6). The frequency step should be chosen to be small enough so that all significant components of the pulse response are included.

  To

  It is recommended that the scatter parameters be measured with a uniform frequency step from a start frequency no greater than 10 MHz to a stop frequency of at least 67 GHz. The measurement frequency step corresponds to the time span of the pulse response derived from the S- parameters (see 178A.1.6. The stop frequency should be chosen high enough and the frequency step should be chosen to be small enough so that all significant components of the pulse response are included and not aliased.

  - Pro: Allows use of current equipment
  - Con: More burden shifted to users

- Option B: Require S-parameter stop frequency of at least 100 GHz
  - Pro: Not hard to do in simulation
  - Con: Hard on equipment requirements
- Option D: Require S-parameter stop frequency of at least 85 GHz
  - Pro: little COM or ERL impact
  - Con: Still hard on instrument requirements
- Option C: Require Rx Device to ignore bandwidth above 67 GHz
  - Pro: Easy on equipment requirements
  - Con: Not practical for Rx devices

Summary

- A 67 GHz stop frequency for s-parameters can impact COM and ERL results
- Most of the time it not an issue
- Recommendation and Discussion: Option A

  "It is recommended that the scattering parameters be measured with a uniform frequency step from a start frequency no greater than 10 MHz to a stop frequency of at least 67 GHz. The measurement frequency step corresponds to the time span of the pulse response derived from the S-parameters (see 178A.1.6). The stop frequency should be chosen high enough and the frequency step should be chosen to be small enough so that all significant components of the pulse response are included and not aliased."

Thank You!

COM Spreadsheets

COM C2M Configuration Spreadsheet

Parameter	Setting	Units	Information
f_b	106.25	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
PKG_NAME	**PKG_HiR_CLASSB PKG_Module**		TX RX
z_p select	[1 2]		
R_0	50		
L	4		
M	32		
filter and Eq			
f_r	0.55	*fb	
c(0)	0.55		min
c(-1)	0		[min:step:max]
c(-2)	0		[min:step:max]
c(-3)	0		[min:step:max]
c(-4)	0		[min:step:max]
c(1)	0		[min:step:max]
N_b	1	UI	
b_max(1)	0.75		As/dffe1
b_max(2..N_b)	0.3		As/dfe2..N_b
b_min(1)	0		As/dffe1
b_min(2..N_b)	-0.15	S	As/dfe2..N_b
g_DC	0	dB	[min:step:max]
f_z	42.50	GHz	
f_p1	42.50	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-5:1:0]		[min:step:max]
f_HP_PZ	1.328125	GHz	
Butterworth	1	logical	include in fr

DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\c2m_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M_eval_	
COM_CONTRIBUTION	0	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	ns
TR_TDR	0.005	
N	1600	logical
TDR_Butterworth	1	
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	0	
N_bx	20	
fixture delay time	[0 0]	
Tukey_Window	1	
Z_t	46.25	179B.4.2
Noise, jitter		UI
sigma_RJ	0.01	UI
A_DD	0.02	V^2/GHz
eta_0	1.00E-08	dB
SNR_TX	33.5	
R_LM	0.95	

Operational			
ERL Pass threshold	10	dB	
COM Pass threshold	3	db	
VEC Pass threshold	10.69	db	
DER_0	2.00E-05		
T_r	0.00400	ns	
FORCE_TR	1	logical	
PMD_type	C2C		
samples_for_C2M	100		
T_O	50		
EW	0		
MLSE	0	logical	
ts_anchor	1		
sample_adjustment	[-16 16]		
Local Search	0		
Filter: Rx FFE			
ffe_pre_tap_len	**5**	UI	
ffe_post_tap_len	14	UI	
ffe_pre_tap1_max	0.7	(normalized)	
ffe_post_tap1_max	0.7	(normalized)	
ffe_tapn_max	0.7	(normalized)	
FFE_OPT_METHOD	MMSE		FV-LMS or MMSE
num_ui_RXFF_noise	1024		
Floating Tap Control			
N_bg	**2**	0 1 2 or 3 groups	
N_bf	4	taps per group	
N_f	50	UI span for floating taps	
bmaxg	0.05	max DFE value for floating taps	
B_float_RSS_MAX	1	rss tail tap limit	
N_tail_start	15	(UI) start of tail taps limit	

COM C2M Package Configuration Spreadsheet

.START	PKG_HiR_CLASSB	
Parameter	**Setting**	**Units**
C_d	[0.4e-4 0.9e-4 1.1e-4 ;0.4e-4 0.9e-4 1.1e-4]	nF
L_s	[0.13 0.15 0.14; 0.13 0.15 0.14]	nH
C_b	[0.3e-4 0.3e-4]	nF
R_d	[46.25 46.25]	Ohm
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
z_p (TX)	[45 45 45 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm
z_p (NEXT)	[45 45 45 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm
z_p (FEXT)	[45 45 45 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm
z_p (RX)	[45 45 45 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm
C_p	[0.4e-4 0.4e-4]	nF
A_v	0.385	V
A_fe	0.385	V
A_ne	0.481	V
.END		

.START	PKG_Module	
Parameter	**Setting**	**Units**
C_d	[0.4e-4 0.9e-4 1.1e-4 ;0.4e-4 0.9e-4 1.1e-4]	nF
L_s	[0.13 0.15 0.14; 0.13 0.15 0.14]	nH
C_b	[0.3e-4 0.3e-4]	nF
R_d	[46.25 46.25]	Ohm
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 ; 100 100; 100 100]	Ohm
z_p (TX)	[4 10 10 10 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm
z_p (NEXT)	[4 10 10 10 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm
z_p (FEXT)	[4 10 10 10 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm
z_p (RX)	[4 10 10 10 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm
C_p	[0.4e-4 0.4e-4]	nF
A_v	0.385	V
A_fe	0.385	V
A_ne	0.481	V
.END		

COM CR/KR Configuration Spreadsheet

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	[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	50	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		As/dfe2..N_b
b_min(1)	0		As/dffe1
b_min(2..N_b)	0	S	As/dfe2..N_b
g_DC	[-10:1:0]	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\CRKR_{date}\	
SAVE_FIGURES	1	logical
Port Order	[1 3 2 4]	
RUNTAG	KR_pkgA_67g6ps	
COM_CONTRIBUTION	0	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	ns
TR_TDR	0.005	
N	4000	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	42.5	
Noise, jitter		UI
sigma_RJ	0.01	UI
A_DD	0.02	V^2/GHz
eta_0	1.00E-08	dB
SNR_TX	33.5	
R_LM	0.95	

Operational		
ERL Pass threshold	10	dB
COM Pass threshold	3	db
DER_0	2.00E-04	
T_r	0.00600	ns
FORCE_TR	1	logical
PMD_type	C2C	
EW	1	
MLSE	1	logical
ts_anchor	1	
sample_adjustment	[-24 24]	
Local Search	2	
Filter: Rx FFE		
ffe_pre_tap_len	**6**	UI
ffe_post_tap_len	15	UI
ffe_pre_tap1_max	0.7	(normalized)
ffe_post_tap1_max	0.7	(normalized)
ffe_tapn_max	0.7	(normalized)
num_ui_RXFF_noise	2048	
Floating Tap Control		
N_bg	**2**	0 1 2 or 3 groups
N_bf	4	taps per group
N_f	80	UI span for floating taps
bmaxg	0.05	max FFE value for floating taps
N_tail_start	16	(UI) start of tail taps limit
pulse response truncation thres	0.00001	
flim	6.70E+10	

COM CR/KR Package Configuration Spreadsheet

.START	PKG_LowR_CLASSA		
Table 93A–3 parameters			
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			