S-Parameter Stop Frequency Impact on COM and ERL

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Comment Reference# 47

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Supporters

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Purpose

- Evaluate the impact of s-parameter frequency range on COM and ERL computations

Process

- Compute COM for a collection of posted s-parameter channel files
  - COM 4.8beta2 was modified to limit s-parameters stop frequency using a parameter “flim”
- Since this is an existence proof, only C2M channels were used
- 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
- 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 configuration was utilized
  - Many more are possible
- COM Parameters taken from d1.3 Annex 176D.6.2 (COM reference model)
- COM configurtaion follows

COM 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 Package Configuration Spreadsheet

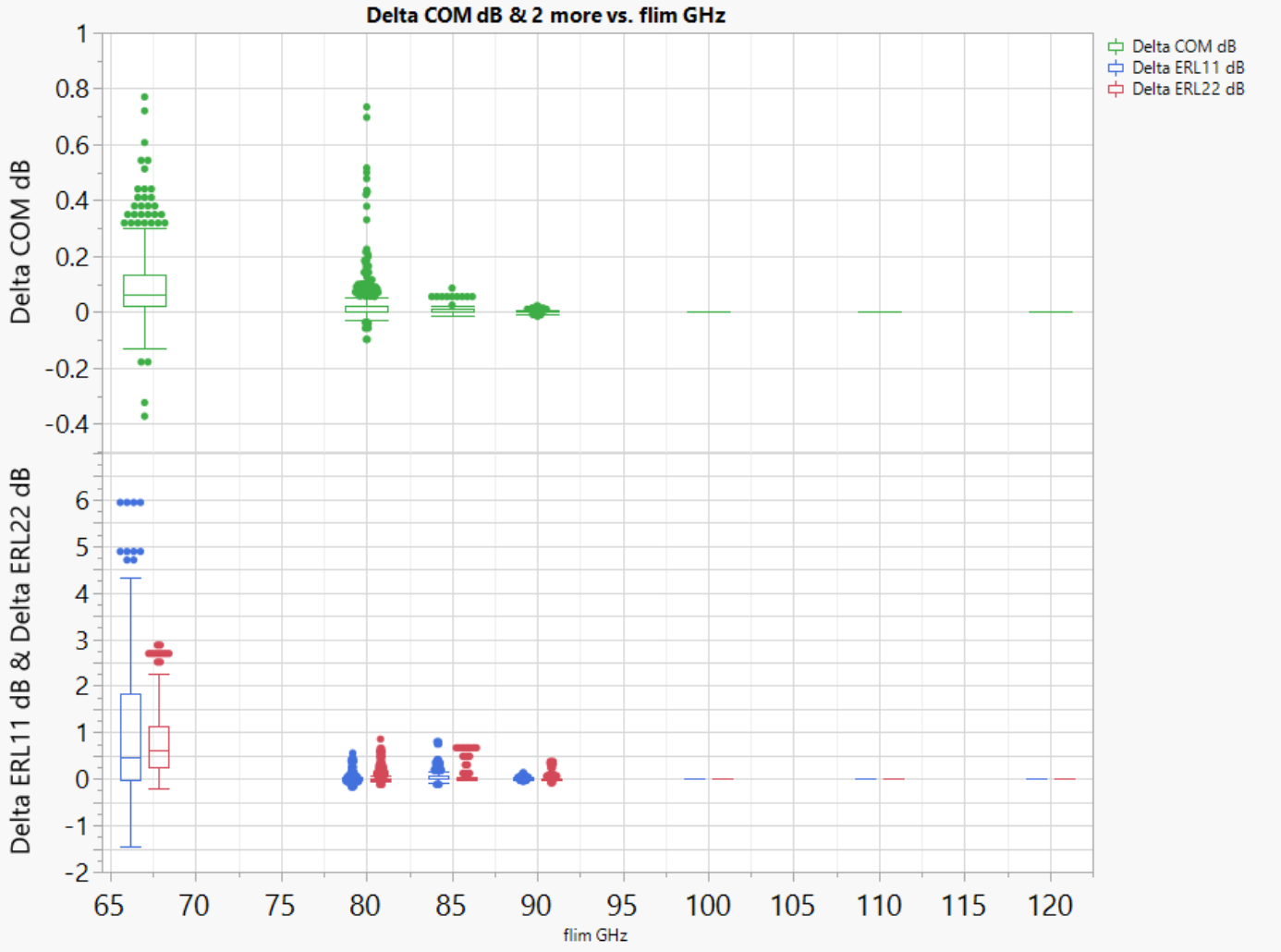
.START	PKG_HiR_CLASSB	
Parameter	**Setting**	**Units**
C_d	[0.4e-4 0.9e-4 1.1e-4 ;0.4e-4 0.9e-4 1.1e-4]	nF
L_s	[0.13 0.15 0.14; 0.13 0.15 0.14]	nH
C_b	[0.3e-4 0.3e-4]	nF
R_d	[46.25 46.25]	Ohm
package_tl_gamma0_a1_a2	[0.0005 0.00065 0.000293]	
package_tl_tau	0.006141	ns/mm
package_Z_c	[87.5 87.5 ; 95 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		

Channel Contribution List (220 Channels)

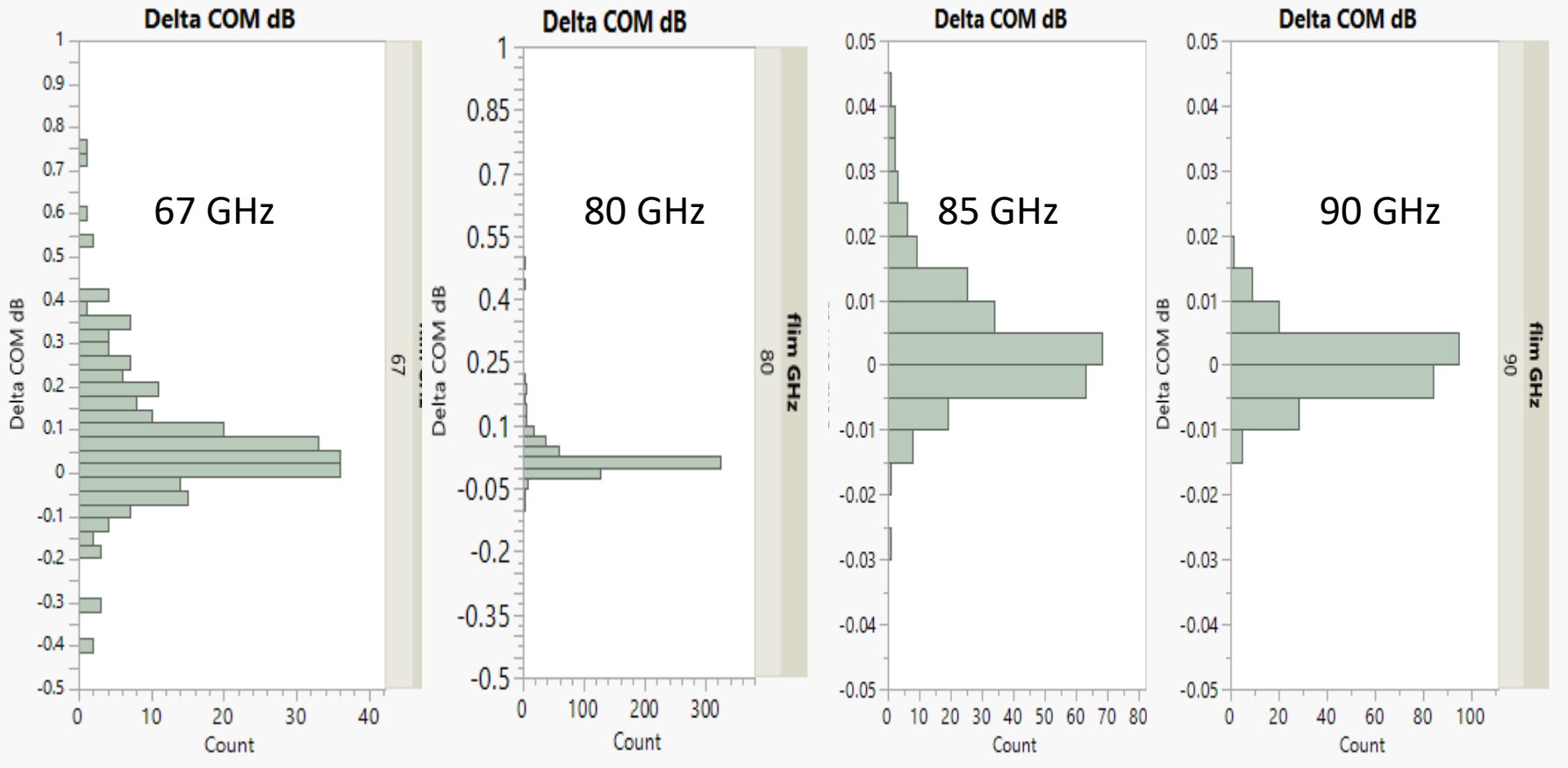
- akinwale_3df_01_2307
- gore_3dj_elec_02_231026a
- kareti_3dj_02_2309
- kareti_3dj_elec_02_240111
- rabinovich_3dj_01_230116
- weaver_3dj_elec_02_230831
- Mated Test Fixture (MTF, January 2025) from Steve Sekel

Snapshot: ΔCOM and ΔERL vs. flim



- Setting stop frequency (flim) to 67 GHz seems to have a big impact on ΔCOM and ΔERL
- Setting flim to 80 GHz does not appear to be high enough to significantly limit ΔCOM
- Details follow

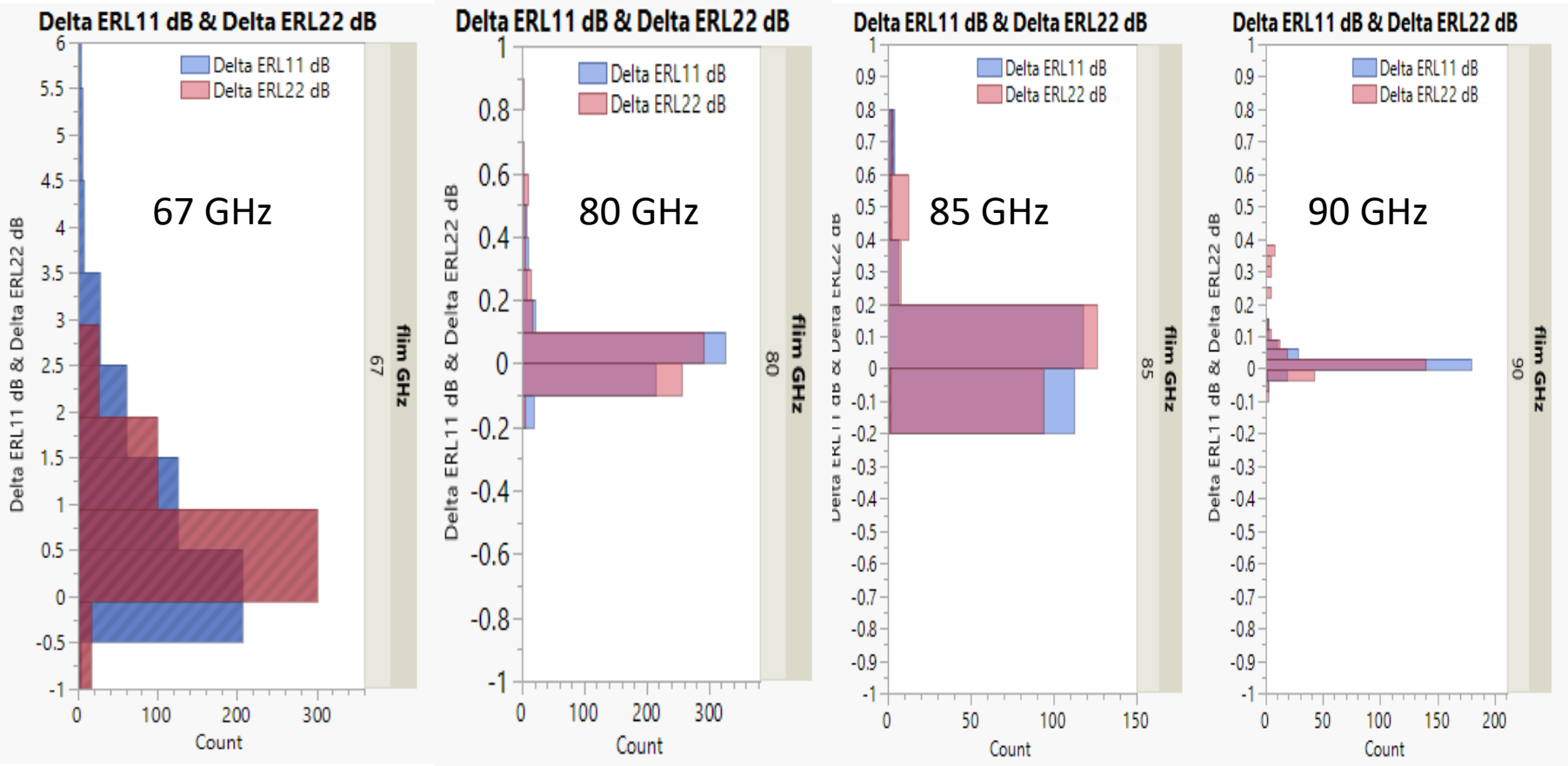
ΔCOM vs. Stop Frequency (flim)



Note y-axis scale is different

- ΔCOM may be up to 0.75 dB when the stop frequency (flim) is set to 67 GHz
- ΔCOM may be up to 0.5 dB when the stop frequency (flim) is set to 80 GHz
- ΔCOM may be up to 0.045 dB when the stop frequency (flim) is set to 85 GHz
- ΔCOM may be up to 0.02 dB when the stop frequency (flim) is set to 90 GHz
- Next: consider when COM is between 2.5 dB and 4 dB

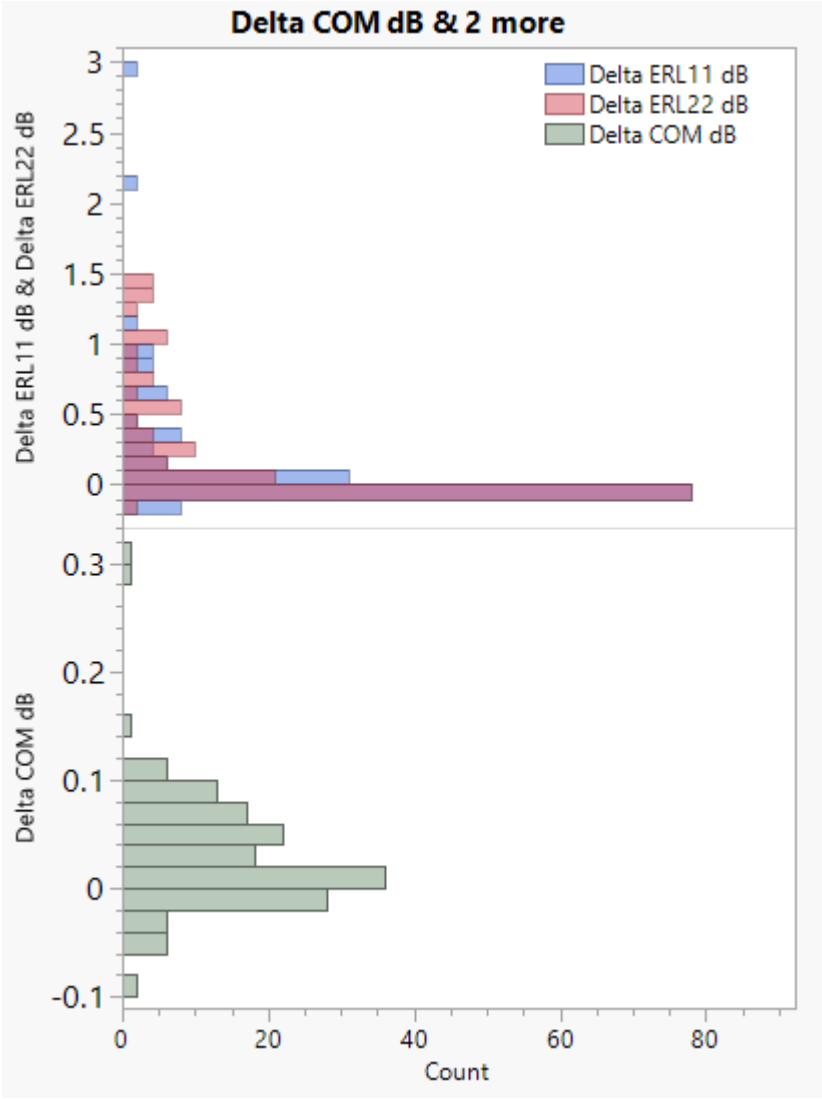
ΔERL vs. Stop Frequency (flim)



- ΔERL may be up to 6 dB when the stop frequency (flim) is set to 67 GHz
- ΔERL may be up to 0.8 dB when the stop frequency (flim) is set to 80 GHz or 85 GHz
- ΔERL may be up to 0.4 dB when the stop frequency (flim) is set to 90 GHz
- Next: consider when COM is between 2.5 dB and 4 dB

Note y-axis scale is different

ΔERL for COM between 2.5 dB and 4.0 dB



- ΔERL range is reduced to +3/-0.1 dB when the stop frequency (flim) is set to 67 GHz
- ΔCOM range is reduced to +0.3/-0.1 dB when the stop frequency (flim) is set to 67 GHz
- Recommend: Go back to specifying ERL on if COM is less than 4 dB only.
- Maybe ΔCOM is not important if channel is around 3 dB of COM.
  - More work required to prove this

Positive and negative ΔCOM

- Positive ΔCOM means the actual (full bandwidth) COM would be lower
  - From a channel perspective, this means the channel has extra margin
  - From a Rx compliance test perspective, this means the Rx needs to tolerate less noise and potential a for false Rx mission pass
- Negative ΔCOM means the actual (full bandwidth) COM would be higher
  - From a channel perspective, this means the channel has negative margin
  - From a Rx compliance test perspective, this means the Rx needs to tolerate more noise and a potential for false mission Rx fail

Options

- Option A: Allow stop frequency = 67 GHz (no change) but account for HF differences in COM, ERL, and Rx testing.
  - If, after specified filtering, significant power exists above the stop frequency or the stop frequency is near a local resonance or anti-resonance, differences in COM and ERL are to be accounted for.
  - Pro: Allows existing instrumentation
  - Con: no standard way to determine how to “account”
- Option B: Require S-parameter stop frequency of 100 GHz
  - Pro: Not hard to do in simulation
  - Con: Hard on equipment requirements
- Option C: Require Rx Device to ignore bandwidth above 67 GHz
  - Pro: Easy on equipment requirements
  - Con: Not practical for Rx devices
- Option D: Require stop frequency = 85 GHz
  - Pro: little COM or ERL impact
  - Con: Still hard on instrument requirements

Summary

- 67 GHz Stop frequency can impact COM and ERL results
- Recommend: Option D
  - Increase stop frequency to 85 GHz
  - Minimal impact on COM (< 0.05 dB) and ERL (< 0.3 dB)
- Recommend specifying ERL only when COM is < 4.0 dB

Thank You!