Exploring 200 Gb/s PAM4 Reference Packages and COM Considerations for C2M and CA

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Supporters

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Purpose

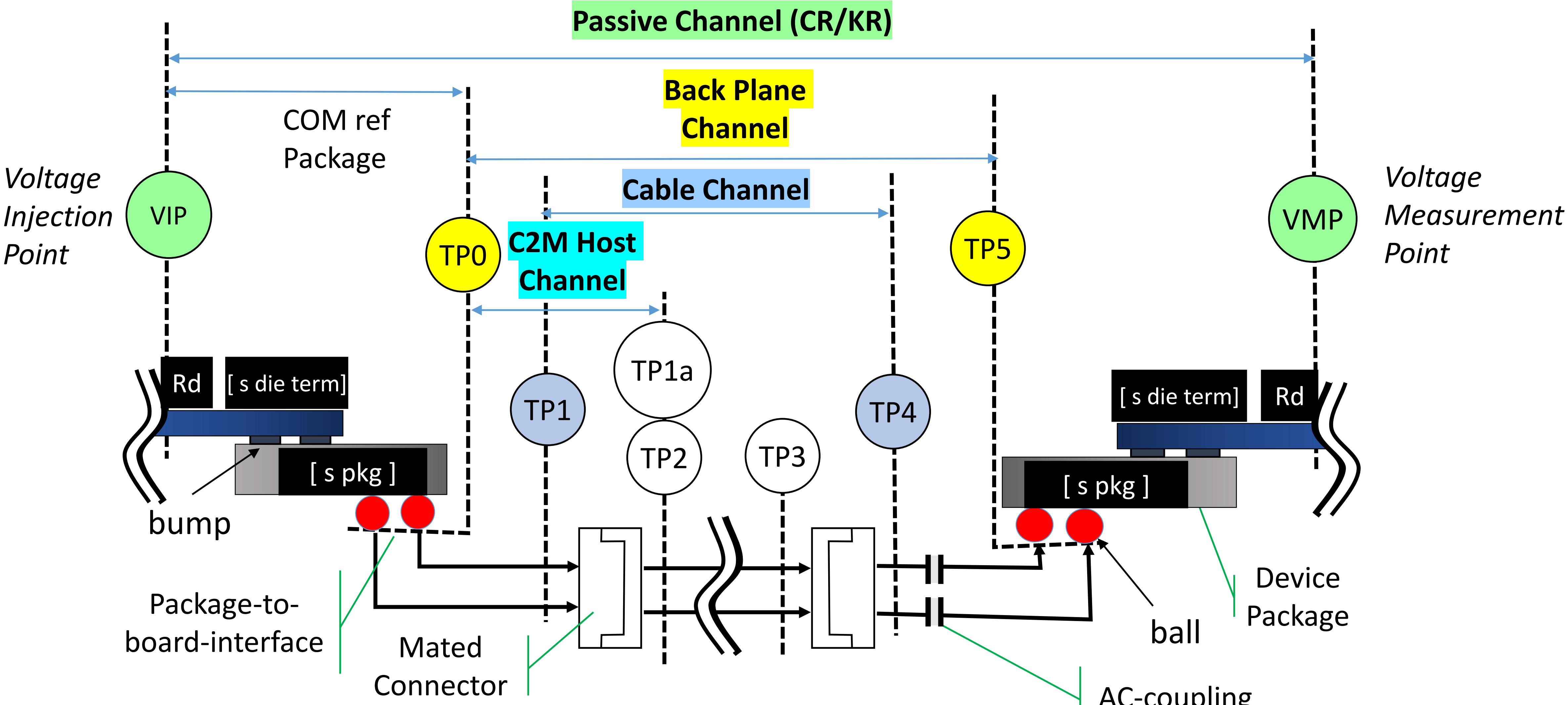
- Provide data to capture some of the 200 Gb/s electrical issues which appear quite challenging due to high package losses
- Illustrate potential methods for improving COM, VEC, and/or VEO results
- Seed new thinking

Impact Topics Covered

- High Loss Packages (at the Nyquist Frequency)
  - Present package and Tx anatomy using Pulse Responses (PR)
- Provide data exploring relative impact of
  - Transmitter compensation for high loss/radix packages (up to 45 mm)
  - Non-symbol based Raised Cosine / Butterworth receiver filtering

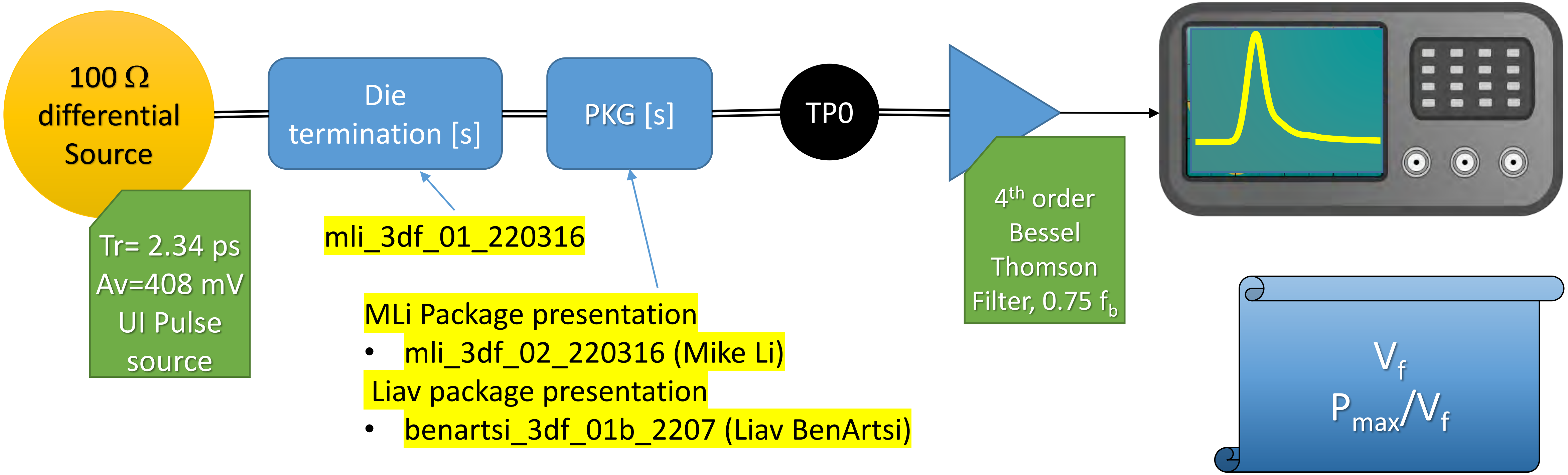
Test Points and Channels

REFERENCE REVIEW

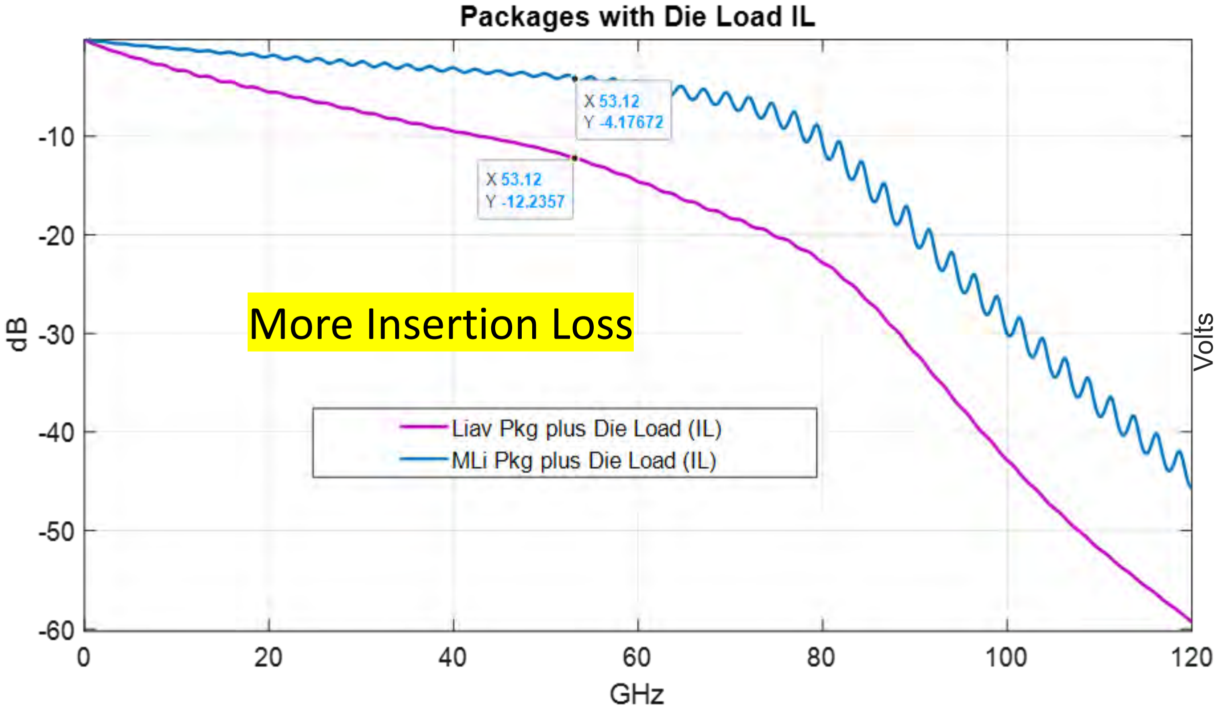


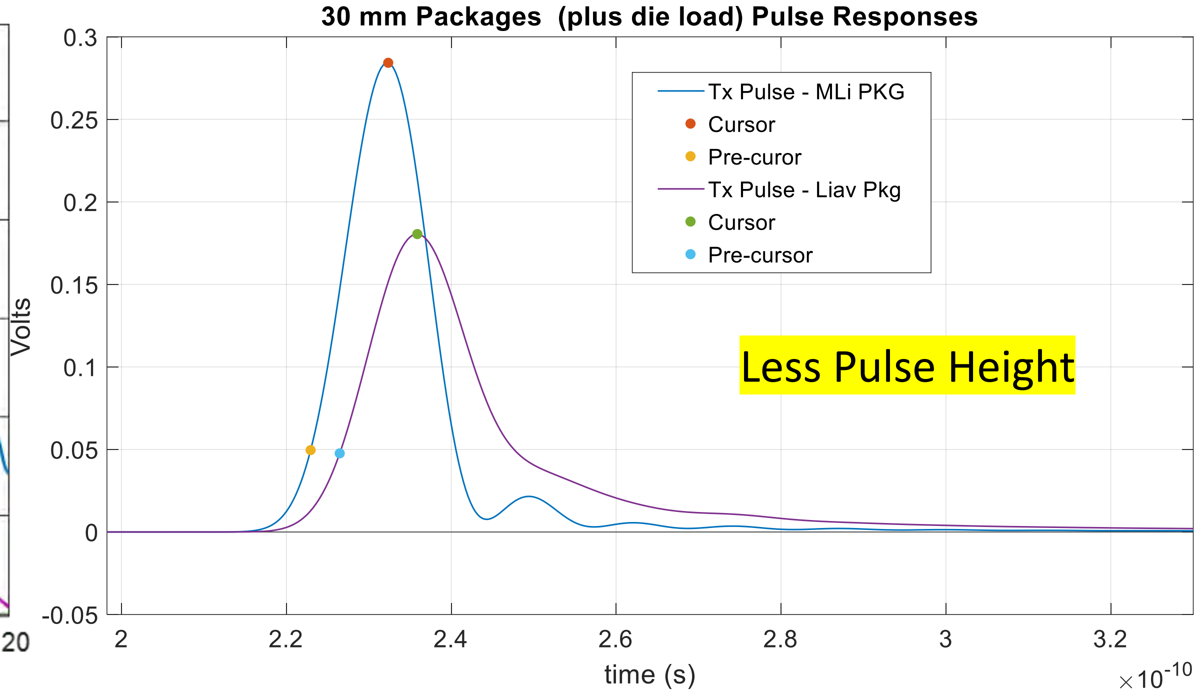
Pulse Response (PR) of a COM Package

REVIEW: TESTING A TRANSMITTER AT TP0
… ADDRESS TP0V LATER



The Liav 30 mm Liav package has more loss than the MLi 30 mm ML package



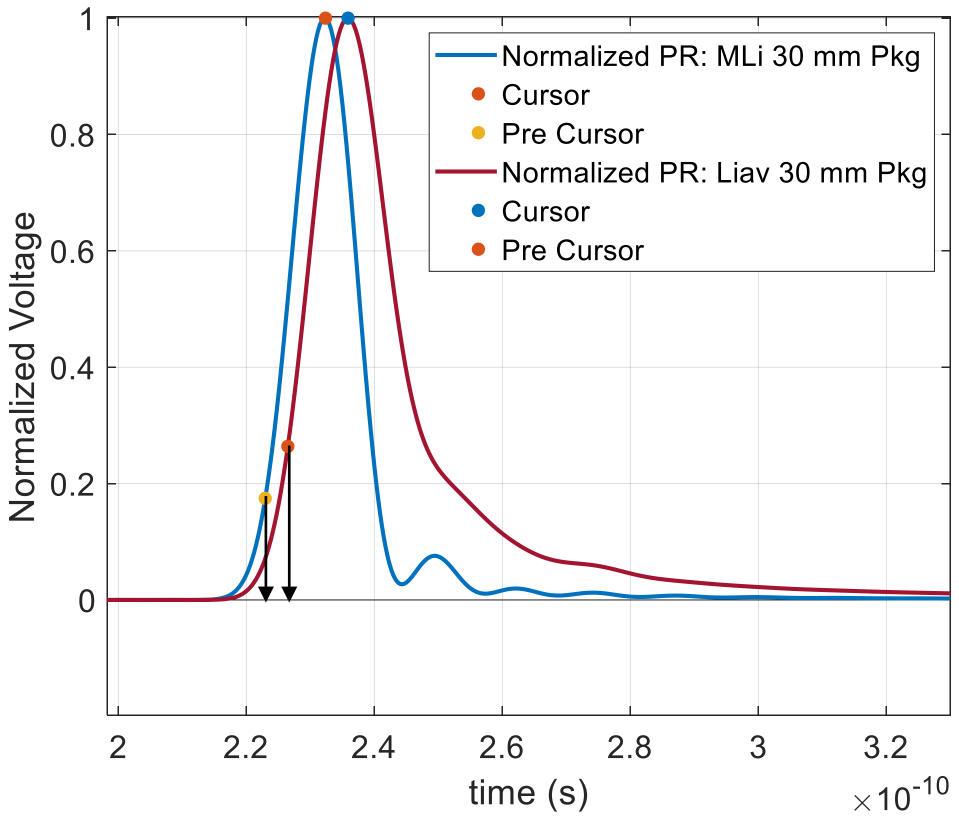


Discussion of Hi Radix package design not covered in this presentation

Food for thought

- Should chip packages with more loss be permitted to pre compensate?
- Can pre-compensation be indirectly specified. I.e., agnostic of design?
- C2M makes no claims here
- C2C/CR/KR Preset 1 ostensibly is up to the chip
- Can pre-compensation be comprehended using COM?

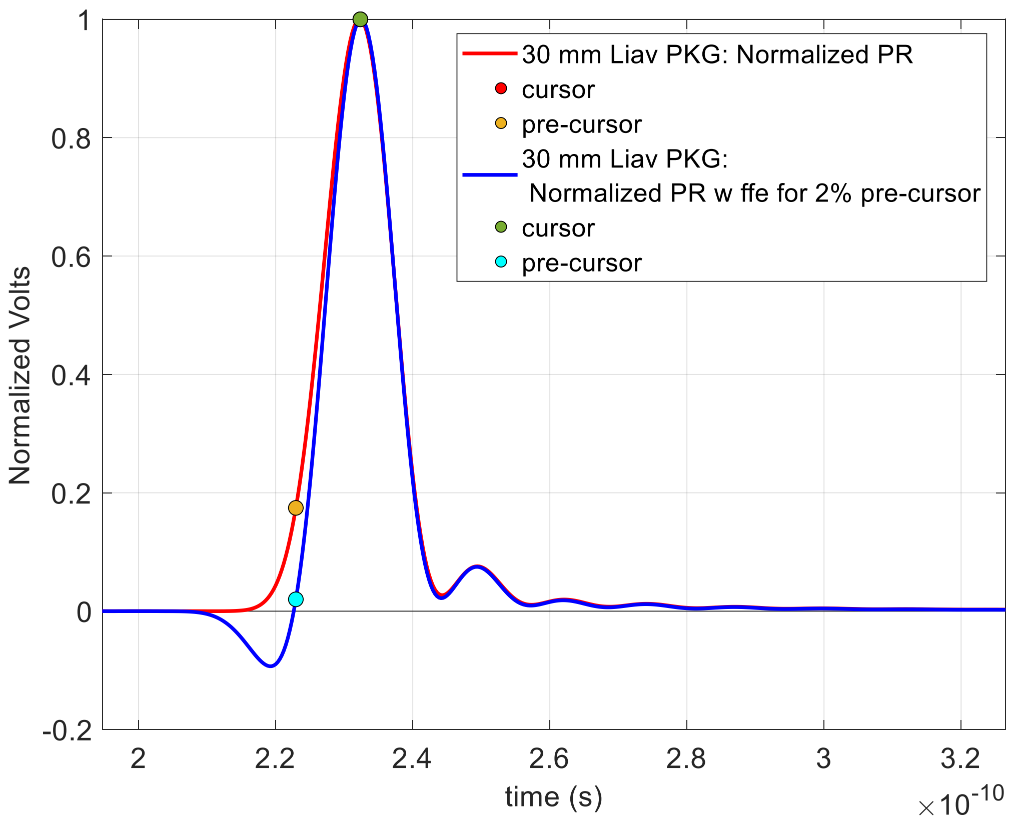
Normalized PR (TP0) Suggests Some Challenges for 200 Gb/s PAM-4 per Lane



- Typically, the effect of tuning the host output may be to bring the precursor to 0.
  - Tuning tends to reduce ISI at the receiver
- Side effect of tuning
  - Loss of signal strength at the transmitter and EH at the receiver
    - However, the goal is to reduce noise more
    - I.e., improves SNR

Large package loss compensation management may be achieved using a pre-cursor measurement/spec

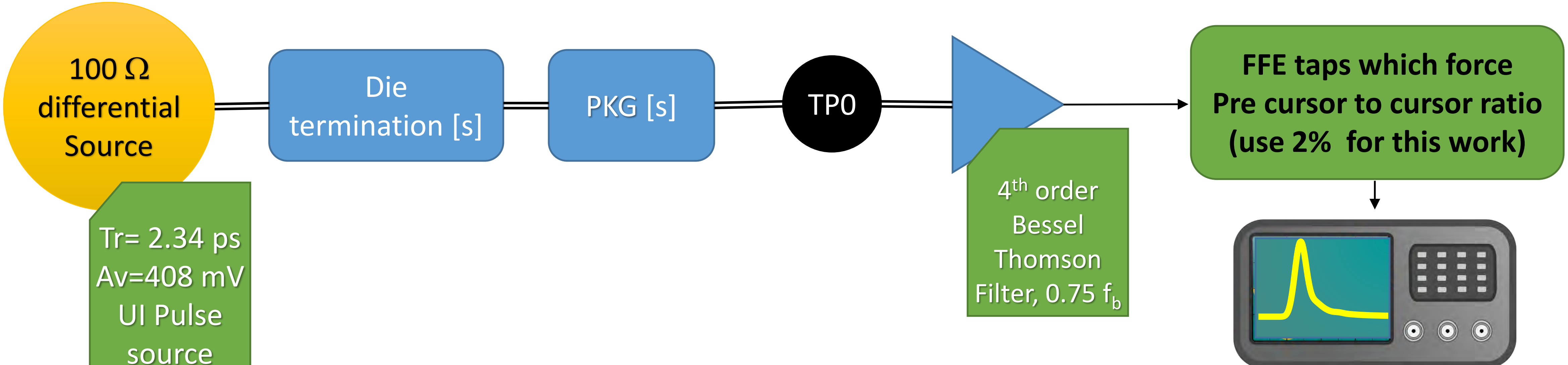
HYPOTHETICALLY, FORCE THE PRE-CURSOR TO … SAY 2%

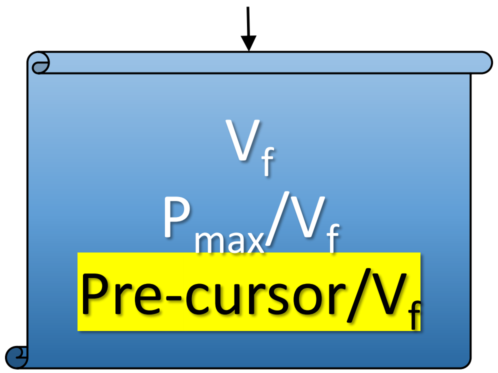


- ❑ Consider another Tx spec at TP0 (v) for Preset 1
  - Add a maximum Pre-cursor to cursor ratio specification
    - Like Annex 120E.3.2
  - Leave it up to chip provider to manage exactly how to do this
- ❑ In COM, this would be implemented with an additional Tx FIR FFE
- ❑ Data and COM examples for this follow

A simple way to pre-compensate a large package

EXAMPLE WHICH EXPLORES A PRE-CURSOR SPECIFICATION

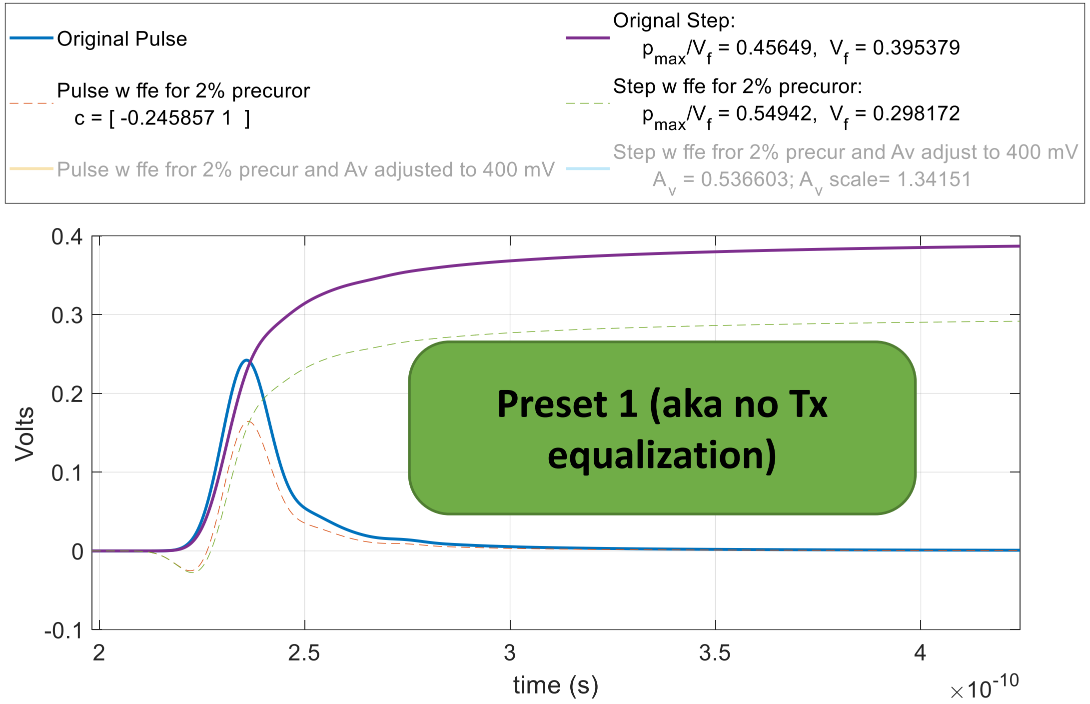


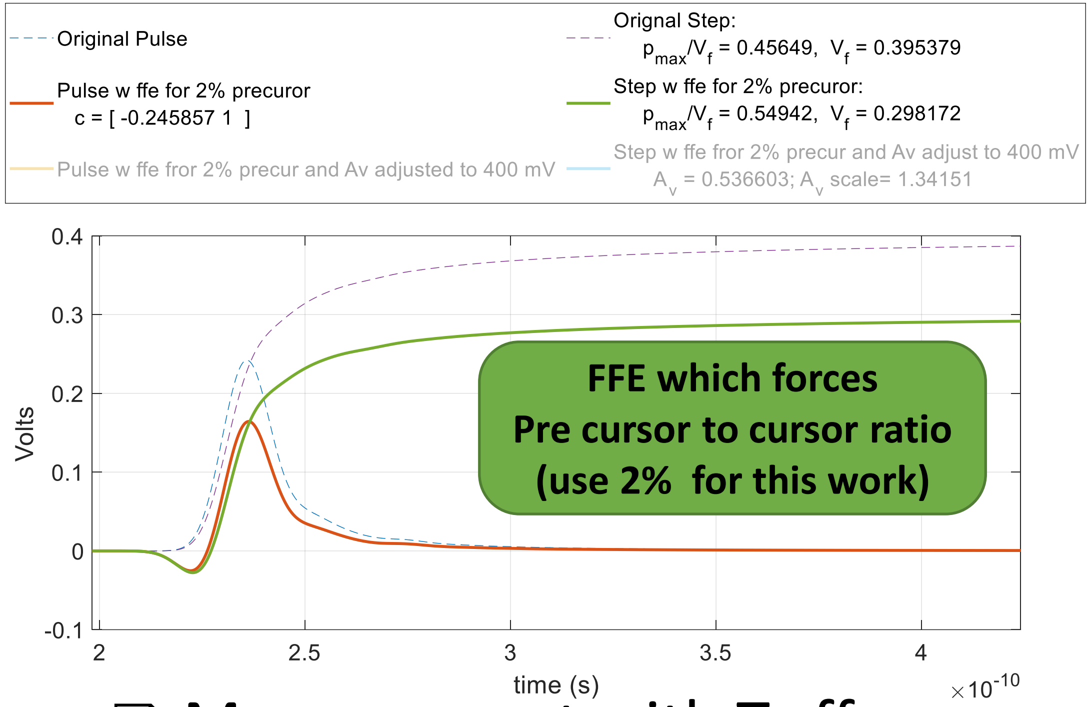


This is only for COM.
A precursor specification is actually agnostic of design

Waveforms illustrating a Tx FFE method to enforce a Maximum Precursor

LIAV 30 MM PKG EXAMPLE





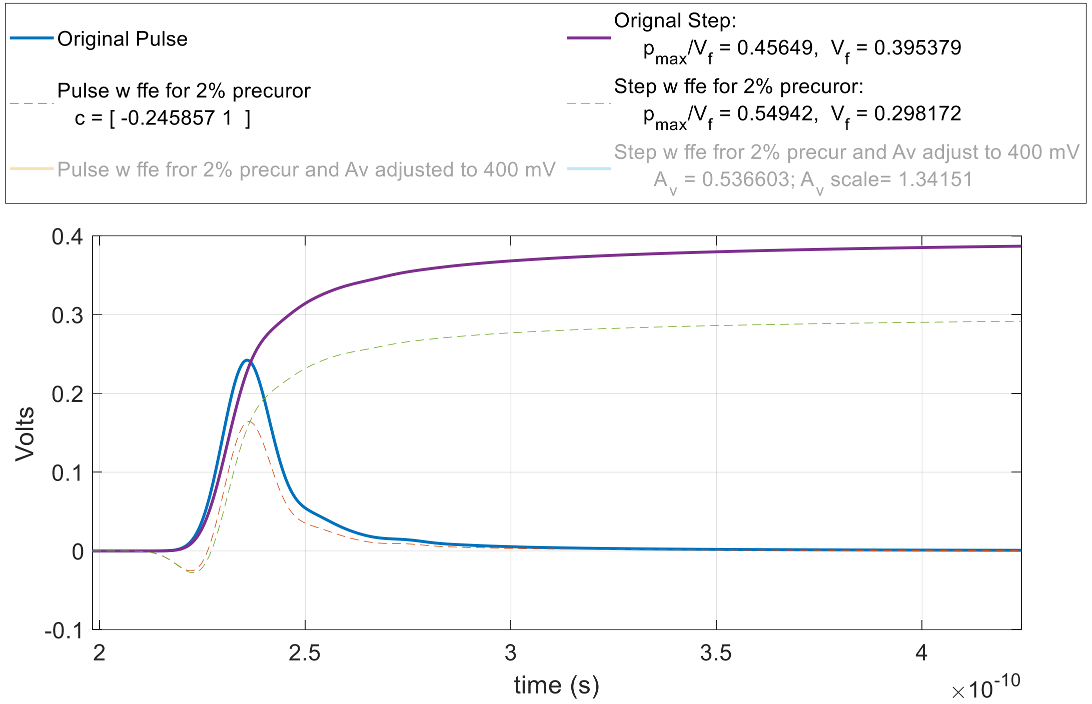
- ❑ Measurement at TP0
- ❑ V_f = 0.395 V

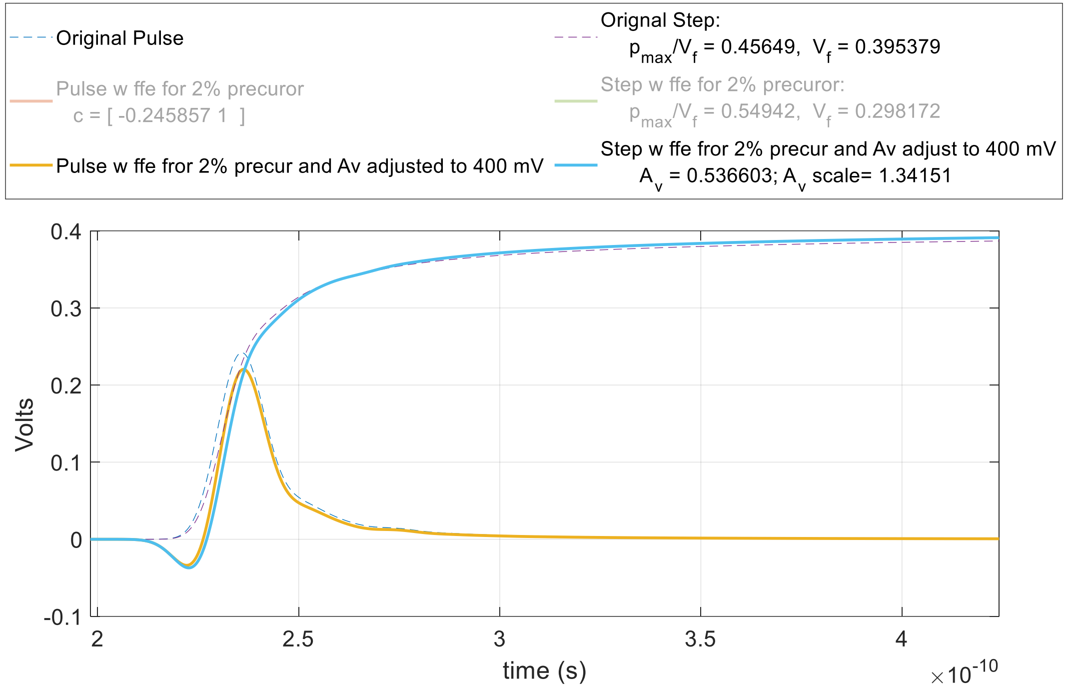
- ❑ Measurement with Tx ffe [-0.245 1] applied
- ❑ V_f = 0.298 V

May result in a lower V_f

Another thought: Realign A_v so that V_f ~ 400 mV

Liav 30 mm package example





- ❑ Measurement at TP0
- ❑ V_f = 0.395 V

The following C2M COM examples do not adjust A_v
The subsequent CA COM example re-adjusts A_v

- ❑ Measurement with Tx ffe [-0.245 1] applied and A_v=0.536
- ❑ Pre-cursor/Cursor set to 2%
- ❑ V_f = 0.400 V

Reference Data for MLi and Liav Packages

FFE taps, c(n); p_{max}/v_f ; A_v

- MLi packages
  - PKG2, 30 mm: c= [-0.1548 1.0], (p_{MAX}/V_f) = 0.7038, A_v=0.457
  - PKG1, 12 mm: c= [-0.1361 1.0], (p_{MAX}/V_f) = 0.7810, A_v= 0.404
  - PKG_Tx_FFE_preset = = [-0.1361 1.0; -0.1548 1.0]
- Liav Packages
  - PKG3, 45 mm c= [-0.3264 1.0], (p_{MAX}/V_f) = 0.4331 , A_v=0.604
  - PKG2, 30 mm: c= [-0.2459 1.0], (p_{MAX}/V_f) = 0.5494 , A_v=0.536
  - PKG1, 12 mm: c= [-0.1687 1.0], (p_{MAX}/V_f) = 0.7473, A_v=0.479
  - PKG_Tx_FFE_preset = = [-0.1687 1.0 ; -.2459 1.0; -0.3264 1.0000]
- Existing COM supports A_v, A_f, and A_n to be cast per package test case
- New COM syntax COM 3.85
  - If 0 or missing keyword, Tx FFE preset is not invoked

PKG_Tx_FFE_preset	0

To be used in subsequent COM examples

Experiments Using Posted Channels

- C2M (chip to module) Host using Liav Packages (12/30/45 mm)
  - Goal: Illustrate impact of filter choices and a maximum precursor specification
  - No V_f realignment
- CA (cable assembly) using Liav Packages (12/30)
  - Goal: Illustrate going one step further and keeping the Vf specification with a maximum precursor specification
  - Tp0 to Tp5 full channel analysis

C2M parameter assumptions for this work

THESE MAY CHANGE BUT PROVIDES A REFERENCE FOR EXPLORING FUTURE WORK

- ❑ Jitter (UI)
  - 0.01 σ_{RJ}
  - 0.02 A_{DD}
- ❑ DFE
  - 8 taps of fixed DFE taps
  - 6 groups of 3 floating taps
  - address B_{max} later
- ❑ DER_0 set to 5e-5
  - FEC choice affect this
- ❑ SNR_Tx = 32.5 dB
  - Conservative estimate
  - Measurements suggest >34 dB is very difficult to achieve
- ❑ ETA_0 = 4.1e-9 V^2/GHz
  - Keep approximately ½ mV RMS at the Rx
  - Same RMS voltage as for .3ck but higher frequency range
- ❑ See back up section for COM configuration details

Replace H_r with $H_{BW}*H_{tw}$

- Butterworth filter, $H_{BW}(f)$ Eq. (93A-20)
  - for this work $f_r = 0.75\ f_b$
- Non-symbol based Raised Cosine (RCos) filter
  - f_{end} chosen to represent upper bandwidth for measurements (80 GHz)
  - f_{start} chosen to be slightly higher than Nyquist (67 GHz)
  - Not a symbol based RCos filter
  - Same $H_{TW}(f)$, Tukey filter, in 93A-58a/b
- f_r , f_{start}, and f_{end} are degrees of freedom for future analysis
- Added for COM 3.80

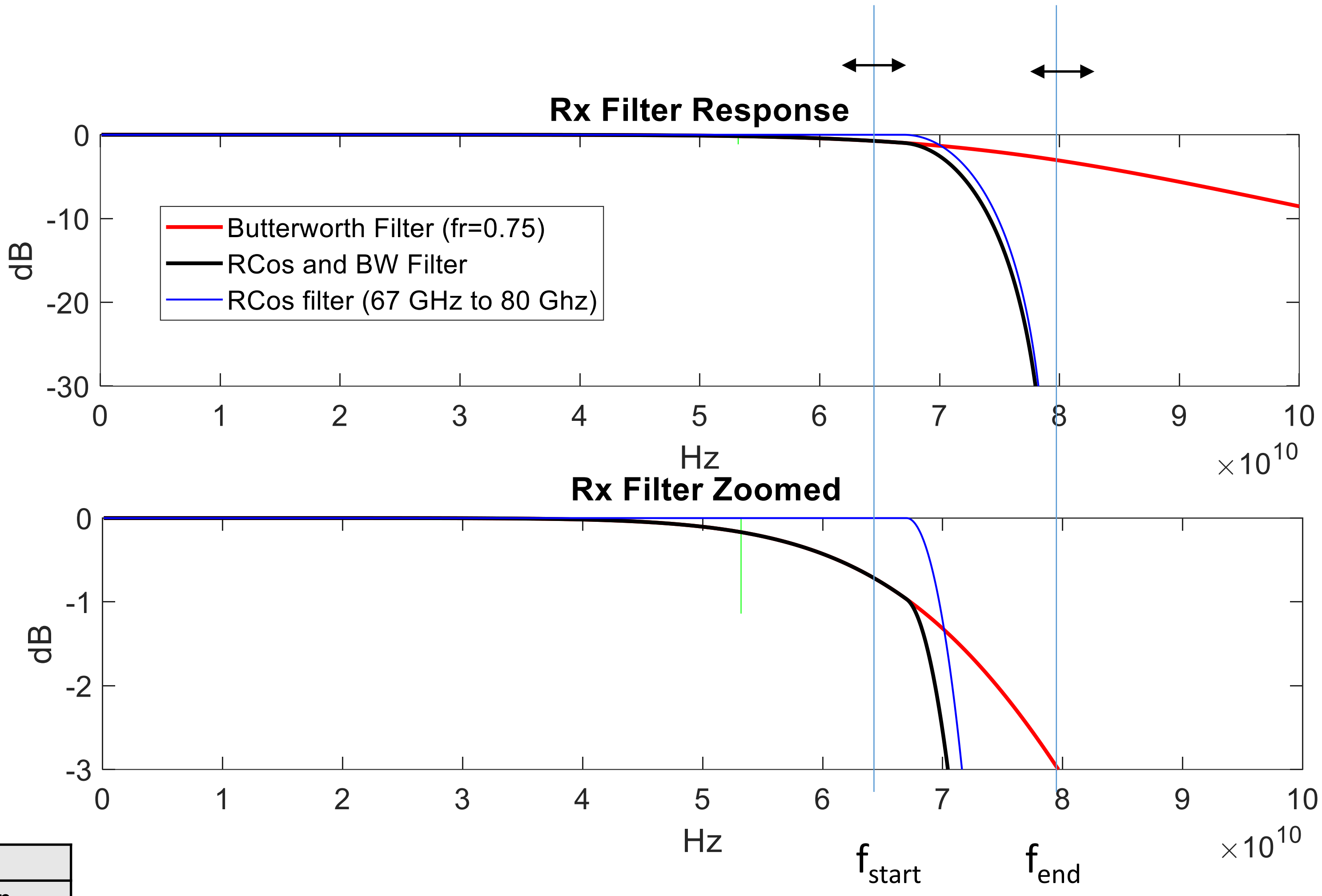


Table 93A-1 parameters			
Parameter	**Setting**	**Units**	**Information**
Butterworth	1	logical	default = 1
Raised_Cosine	0	logical	default = 0
RC_Start	6.70E+10	Hz	start freq for RCos
RC_end	7.97E+10	Hz	end freq for RCos

f_{end} would be the highest frequency for s-parameter acquisition

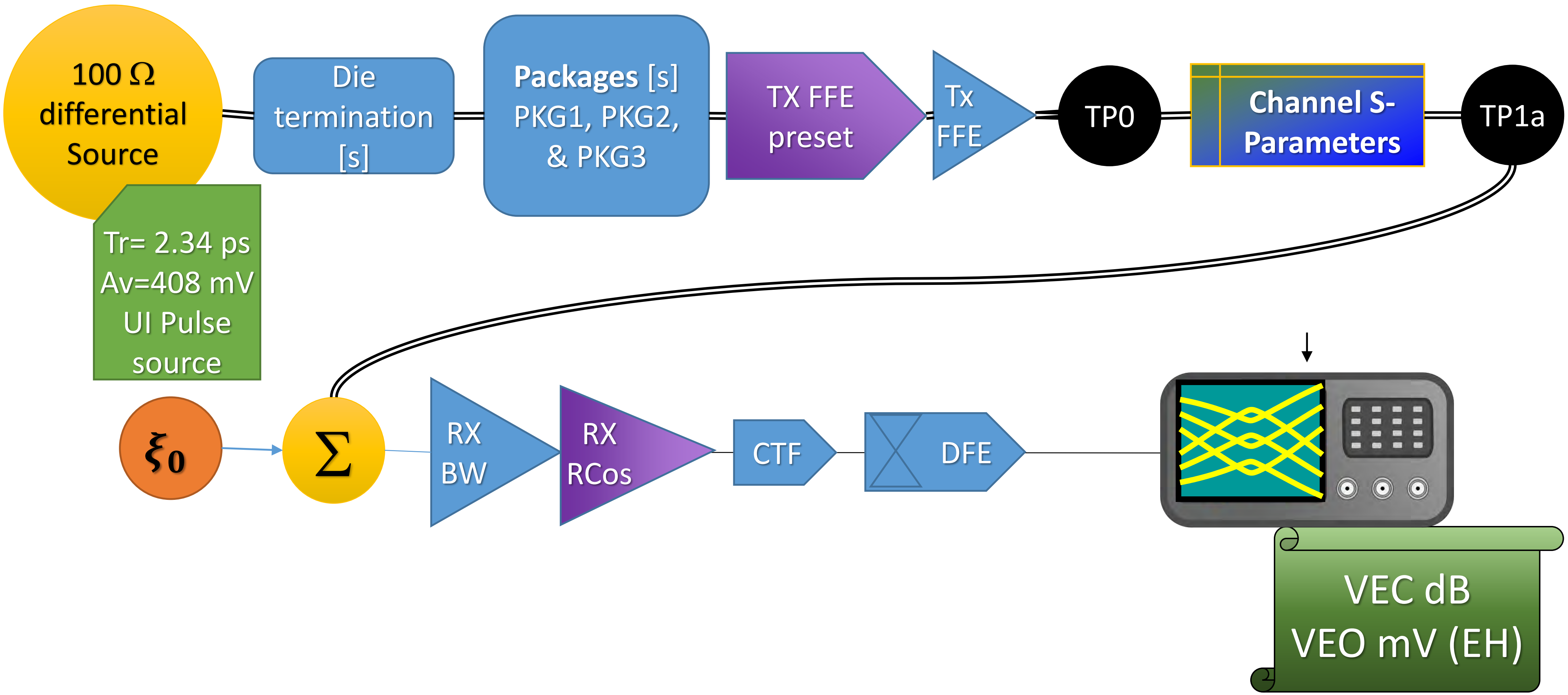
C2M Graph Syntax Key

Liav Packages used in the following C2M experiments

- "Default"
  - Butterworth filter with f_r = 0.75 f_b
- "RCos_BW"
  - Raised Cosine filter (Tukey) f_{start}= 67 GHz, f_{end}= 80 GHz
  - Butterworth filter with f_r at 0.75 f_b
- "BW_Txpre"
  - Butterworth filter with f_r at 0.75 f_b
  - PKG_Tx_FFE_preset = = [-0.1687 1.0; -0.2459 1.0]
- "RCos_BW_Txpre"
  - Raised Cosine filter (Tukey) f_{start}= 67 GHz, f_{end}= 80 GHz
  - Butterworth filter with f_r at 0.75 f_b
  - PKG_Tx_FFE_preset = = [-0.1687 1.0; -0.2459 1.0]

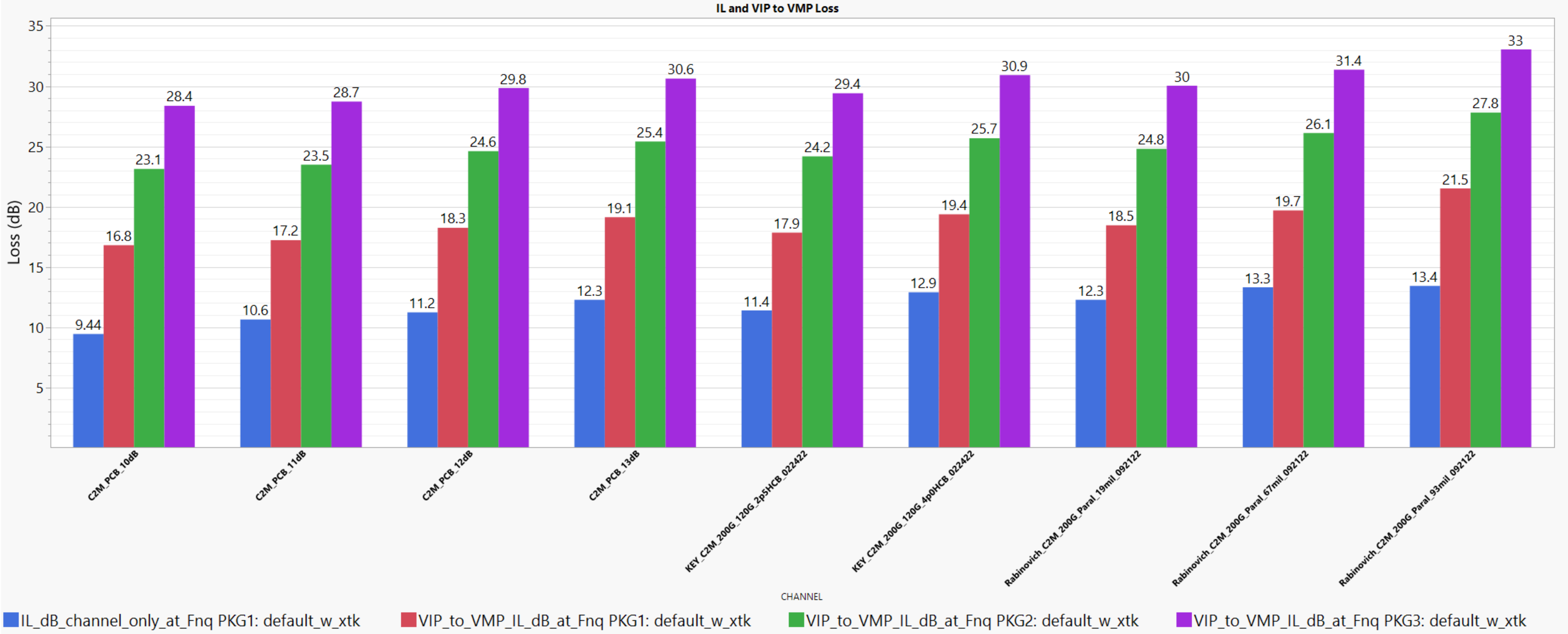
Basic C2M Simulation/Measurement Diagram

CROSSTALK DIAGRAM IS SIMILAR



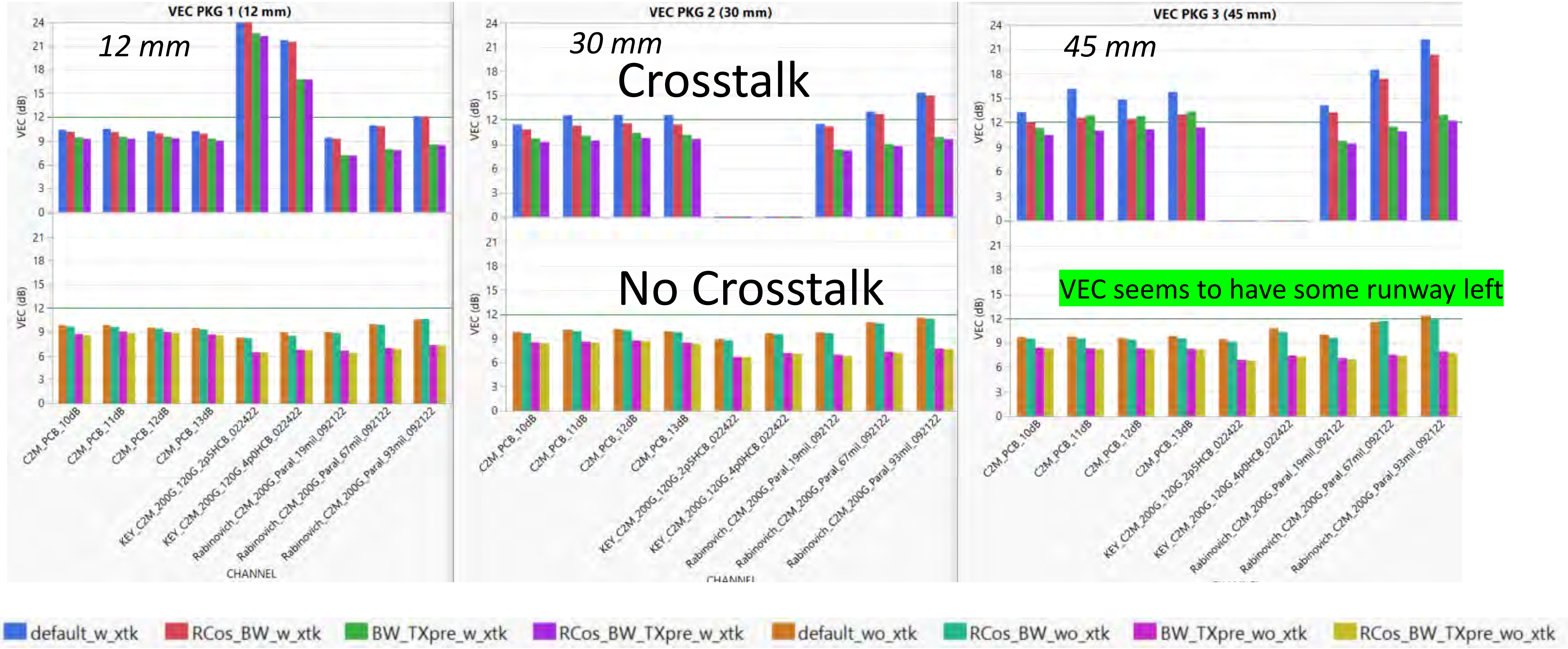
Insert loss of channel, tp0-tp1a is between 9.44 dB and 13.4 dB (at 53.125 GHz)

VIP to VMP between is
17-21dB (PKG1), 23-28 dB (PKG2), 24-33dB (PKG3)



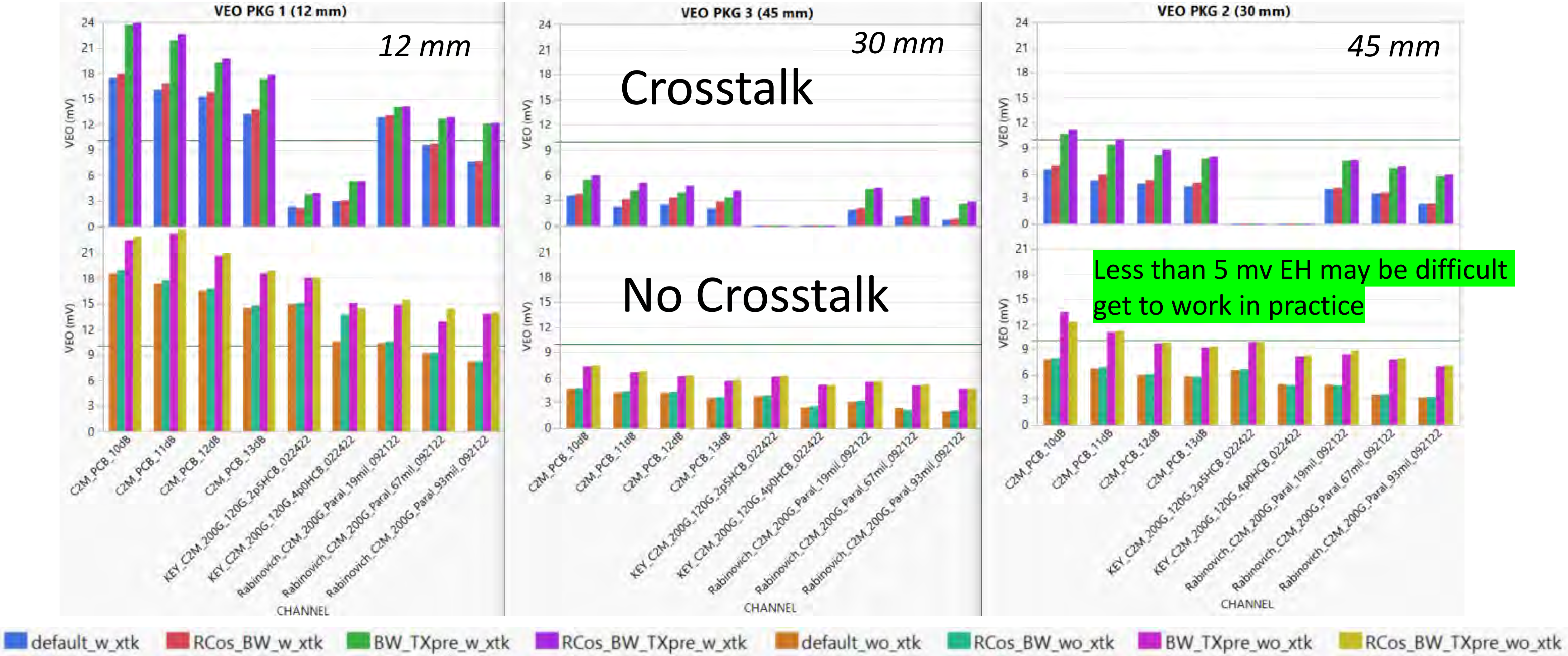
VEC RESULTS – Liav Package (PKG 1 2 3)

HIGHER VEC IS LESS MARGIN



VEO(EH) – Liav 12 mm, 30 mm, 45 mm package

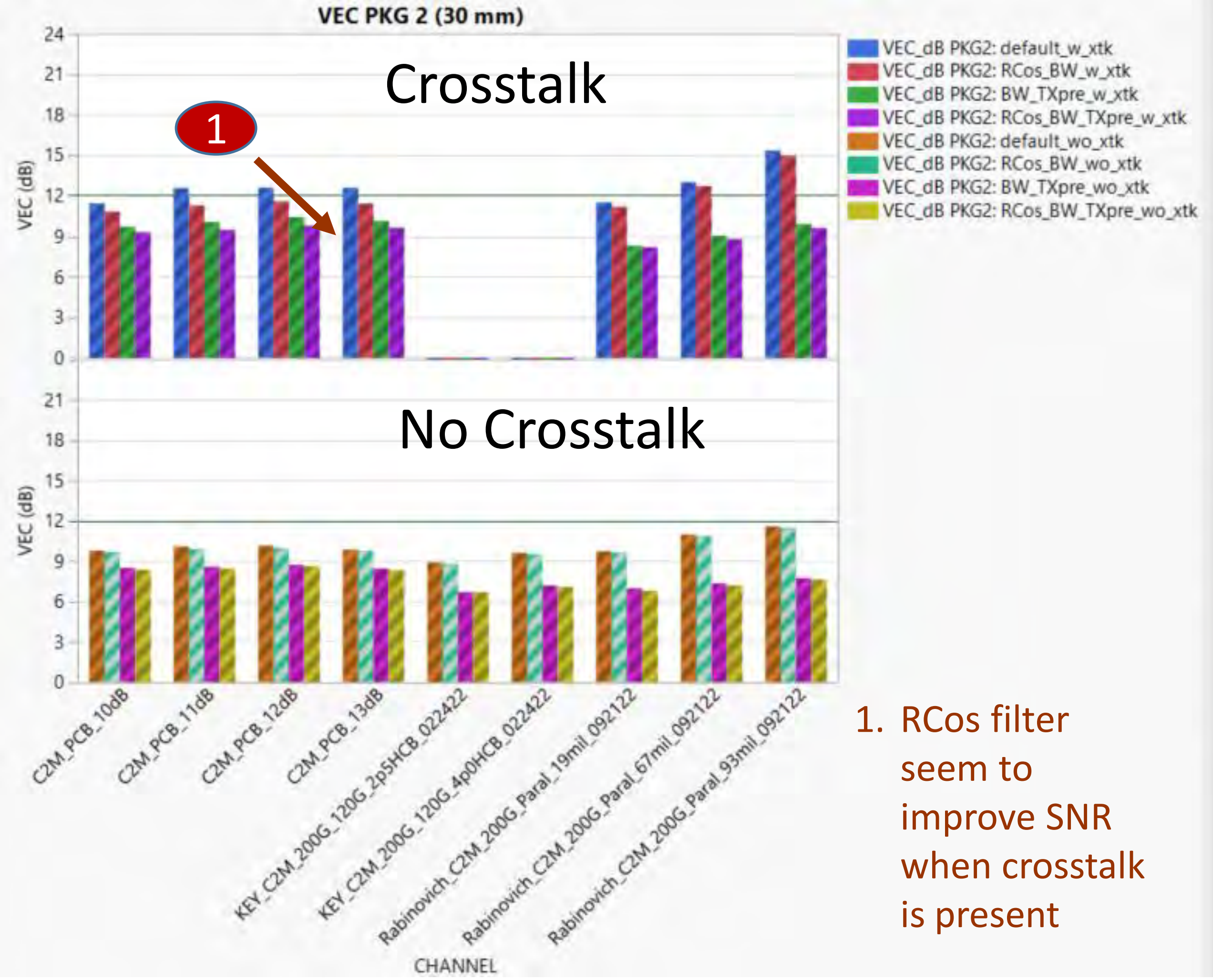
WITH AND WITHOUT CROSSTALK



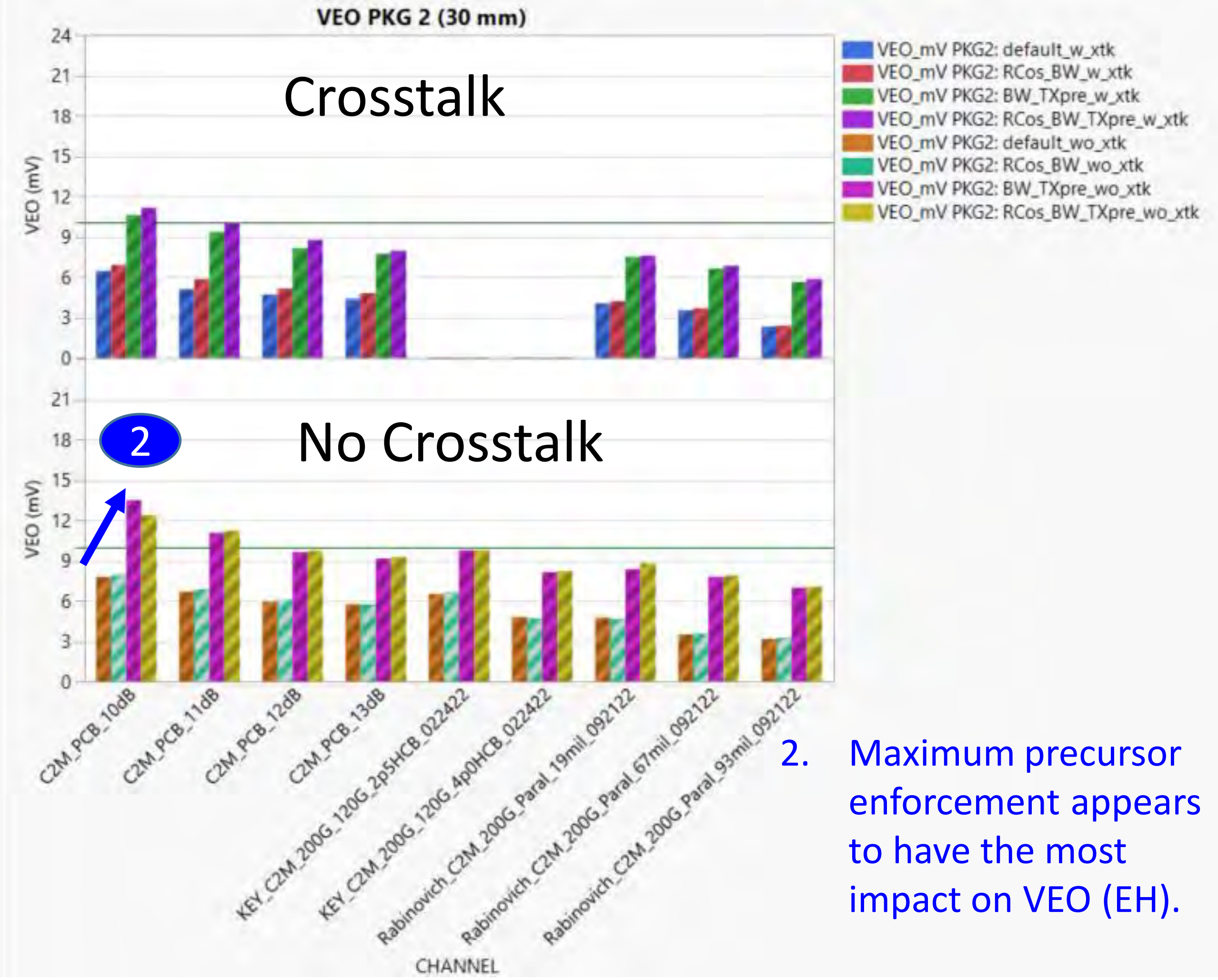
VEC and VEO Trend Assessment Using PKG 2 (30 mm)

THIS DATA IS WITH NO V_F REALIGNMENT

- V_f realignment to 400 mV would add about 1 mv VEO (EH) and reduce VEC by 1.5 dB



1. RCos filter seem to improve SNR when crosstalk is present



2. Maximum precursor enforcement appears to have the most impact on VEO (EH).

Goal for CA (Cable Assembly) Work

- Explore if a realignment of Av to keep V_f at 400 mV would improve CA performance

CR CA parameter assumptions for this work

THESE MAY CHANGE BUT PROVIDES A REFERENCE FOR EXPLORING FUTURE WORK

- Jitter (UI)
  - 0.01 σ_{RJ}
  - 0.02 A_{DD}
- DFE
  - 24 taps of fixed DFE taps
  - 6 groups of 3 floating taps
  - address B_{max} later
- DER_0 set to 5e-4
  - FEC choice affect this
- SNR_Tx = 33 dB
  - Conservative estimate
  - Measurements suggest >34 dB is very difficult to achieve
- ETA_0 = 4.1e-9 V^2/GHz
  - Keep approximately ½ mV RMS at the Rx
  - Same RMS voltage as for .3ck but higher frequency range
- See backup section for COM configuration details

CA Graph Syntax Key

PACKAGE B USED IN THE FOLLOW C2M EXPERIMENTS

- TP0-TP5 Default (MLiPKG and LiavPKG)
  - Butterworth filter with $f_r = 0.75\ f_b$
- TP0-TP5_RC_BW_TXPre LiavPKG w Av adjust
  - Raised Cosine filter (Tukey) f_{start}= 67 GHz, f_{end}= 80 GHz
  - PKG_Tx_FFE_preset = [-0.1687 1.0; -.2459 1.0]
  - Butterworth filter with f_r at 0.75 f_b
  - $A_v(A_f)$=0.536
- TP0-TP5_RC_BW_TXPre LiavPKG no Av adjust
  - Raised Cosine filter (Tukey) f_{start}= 67 GHz, f_{end}= 80 GHz
  - PKG_Tx_FFE_preset = [-0.1687 1.0; -.2459 1.0]
  - Butterworth filter with f_r at 0.75 f_b
  - $A_v(A_f)$=0.408

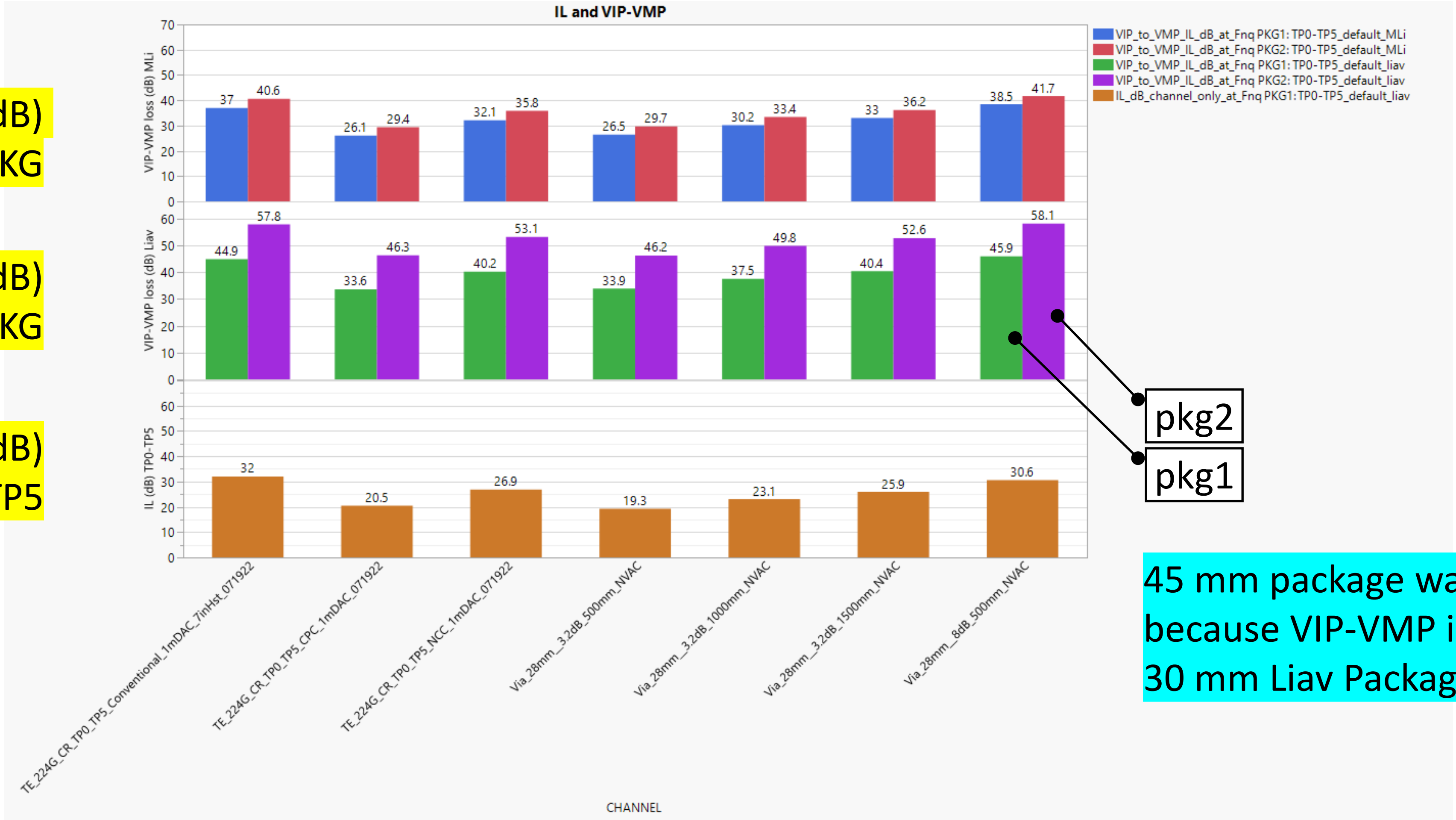
VIP-VMP loss is quite high

Channels with Liav 30 mm PKG (purple bar) have a VIP-VMP loss greater that 46 dB

VIP-VMP loss (dB) Mli PKG

VIP-VMP loss (dB) Liav PKG

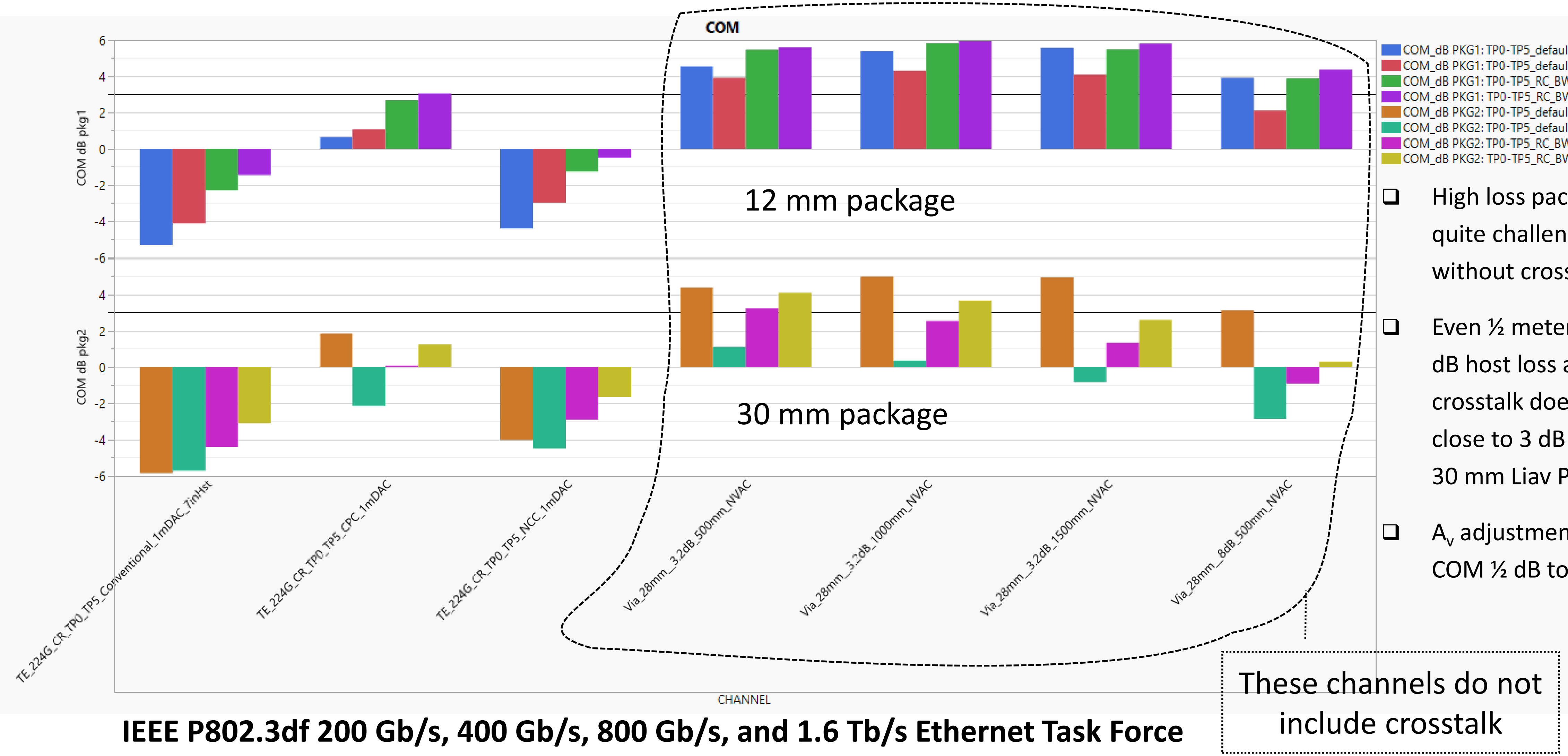
Channel IL (dB) TP0-TP5



45 mm package was not considered because VIP-VMP is > 46 dB for the 30 mm Liav Package

CA COM results (Full channel Liav PKG)

CROSSTALK SEEMS LIKE A CONCERN



- High loss packages seem quite challenged even without crosstalk
- Even ½ meter cable with 8 dB host loss and no crosstalk does not come close to 3 dB COM for the 30 mm Liav Package
- A_v adjustment improves COM ½ dB to 1 dB

Results

C2M Results

- ❑ Host channels with high radix / high loss packages and channel loss (Tp0-Tp1a) between 9.5 dB and 12.5 dB seem to have a runway with improvements from
  - More filtering:
    - Tukey filter (non symbol based raised cosine filtering)
  - The bottom line is the question are large package responsible for their loss?
    - Tx Precursor specifications for preset 1 condition can address at that
    - So can a larger value for p_{max}/V_f

CA Result

- ❑ Total loss seems to stress physical architecture assumptions for a single electrical passive CA electrical path
- ❑ Channels with high loss packages termination seems to have an SNR far from workable .
  - Even with improvements from
    - Tukey filter (non symbol based raised cosine filtering)
    - Precursor specifications for preset 1 condition.
  - Perhaps this would be workable for a low radix package and low crosstalk
  - V_f re-aligned to 400 mV (using A_v) can improve COM by up to 1 dB
    - … but not enough

Summary

Tukey filter (non symbol based raised cosine filtering), RCos

- ❑ The RCos filter used along with the Butterworth filter provides clear limits for measurement bandwidth as well as improving performance
  - May need refinement of f_{start}, f_{end}, and f_r once more channels become available
  - Preserves the Butterworth nature of the filter below f_{start}.
  - Provides a clear direction for instrumentation and measurement!
    - Do not leave bandwidth truncation up to the user.

Tx Precursor specifications for preset 1 condition

- ❑ Offer significant improvement of VEC and EH for channels with high loss packages
  - Even without V_f realignment

Thank You!

Backup Reference

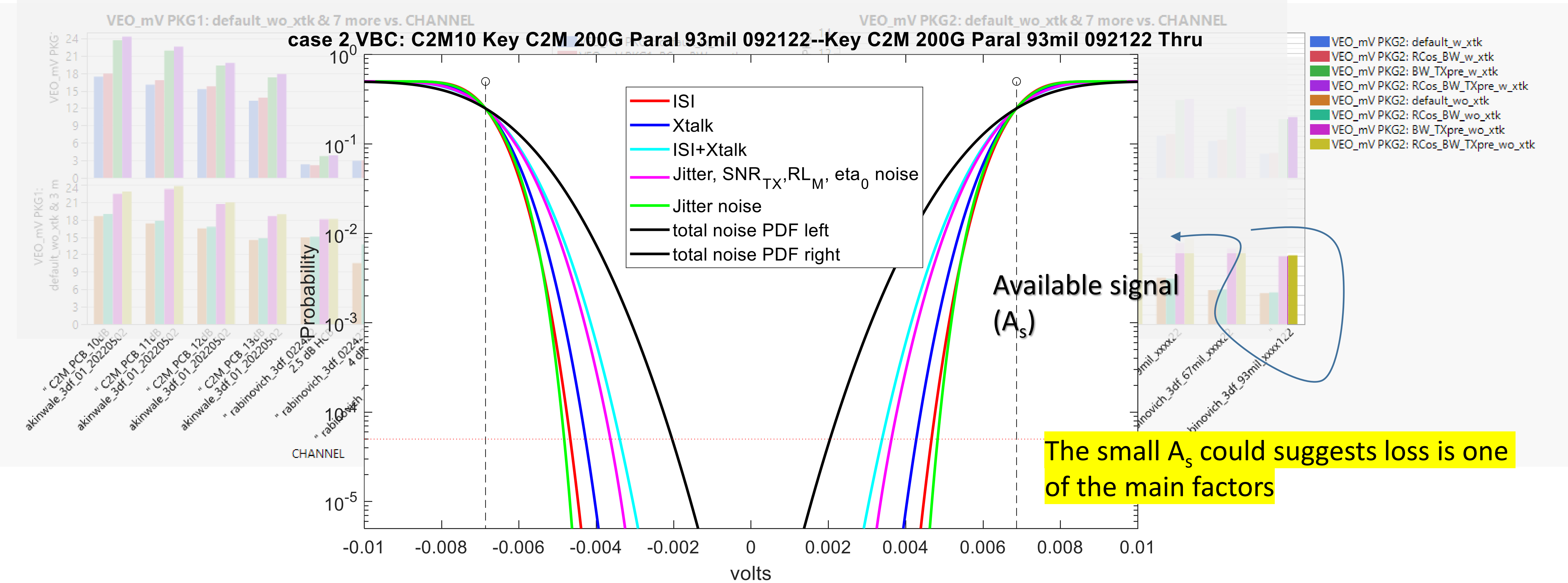
- ❑ Channel references
- ❑ COM spreadsheet bases

Channels

- C2M references
  - https://www.ieee802.org/3/df/public/tools/c2m/akinwale_3df_01_220502.zip
    - C2M_PCB_10dB
    - C2M_PCB_11dB
    - C2M_PCB_12dB
    - C2M_PCB_13dB
  - https://www.ieee802.org/3/df/public/tools/c2m/rabinovich_3df_022422.zip
    - KEY_C2M_200G_120G_2p5HCB_022422_Thru
    - KEY_C2M_200G_120G_4p0HCB_022422_Thru
  - Sept 21 contribution from Rick Rabinovich
    - Rabinovich_C2M_200G_Paral_19mil_092122_Thru
    - Rabinovich _C2M_200G_Paral_67mil_092122_Thru
    - Rabinovich _C2M_200G_Paral_93mil_092122_Thru
- CA references
  - https://www.ieee802.org/3/df/public/tools/CR/tracy_3df_01a_2207_s4p.zip
    - TE_224G_CR_TP0_TP5_Conventional_1mDAC_7inHst_071922 w XTLK
    - TE_224G_CR_TP0_TP5_CPC_1mDAC_071922_THRU w XTLK
    - TE_224G_CR_TP0_TP5_NCC_1mDAC_071922_THRU w XTLK
  - https://www.ieee802.org/3/df/public/tools/CR/mellitz_3df_01_220502.zip
    - Via_28mm__3.2dB_1000mm_NVAC_thru no XTLK
    - Via_28mm__3.2dB_1500mm_NVAC_thru no XTLK
    - Via_28mm__3.2dB_500mm_NVAC_thru no XTLK
    - Via_28mm__8dB_500mm_NVAC_thru no XTLK

C2M Example: How To Dig Deeper Into The Signal And Noise Budget

The biggest contributor for this run is ISI and crosstalk followed by the system noise



The small A_s could suggests loss is one of the main factors

C2M Host Configuration Base for MLi PKG

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 0 0]	nF	[TX RX]
L_s	[.12 .15 .14; 0 0 0]	nH	[TX RX]
C_b	[.3e-4 0]	nF	[TX RX]
z_p select	[1 2 3 4]		[test cases to run]
z_p (TX)	[12 30; 1.0 1.0]	mm	[test cases]
z_p (NEXT)	[0 0 ; 0 0]	mm	[test cases]
z_p (FEXT)	[12 30; 1.0 1.0]	mm	[test cases]
z_p (RX)	[0 0 ; 0 0]	mm	[test cases]
PKG_Tx_FFE_preset	0		
C_p	[0.4e-4 0]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.408	V	vp/vf=
A_fe	0.408	V	vp/vf=
A_ne	0.608	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.65		min
c(-1)	[-0.2:0.02:0]		[min:step:max]
c(-2)	[0:.02:0.1]		[min:step:max]
c(-3)	[-0.1:.02:0]		[min:step:max]
c(1)	[-0.2:0.02:0]		[min:step:max]
N_b	8	UI	
b_max(1)	**0.85**		As/dffe1
b_max(2..N_b)	**0.15**		As/dfe2..N_b
b_min(1)	**0**		As/dffe1
b_min(2..N_b)	-0.15		As/dfe2..N_b
g_DC	[-13:1:0]	dB	[min:step:max]
f_z	42.5	GHz	
f_p1	42.5	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	1.0625	GHz	
Butterworth	1	logical	include in fr
Raised_Cosine	0	logical	include in fr
RC_Start	6.70E+10	Hz	start freq for RCos
RC_end	7.97E+10	Hz	end freq for RCos

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\c2m106_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M TP1a	
COM_CONTRIBUTION	0	logical
Operational		
ERL Pass threshold	10	dB
VEC Pass threshold	12.5	db
DER_0	5.00E-05	
T_r	2.35E-03	ns
FORCE_TR	1	logical
Min_VEO_Test	1	mV
PMD_type	C2M	
EH_min	10	Value
EH_max	1000	Value
T_O	50	mUI
samples_for_C2M	100	samples/UI
Dynamic TXFFE	1	
FloatingDFE_Development	1	
EW	1	
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	6000	
TDR_Butterworth	1	logical
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	0	
N_bx	8	UI
fixture delay time	[0 0.2e-9]	
Tukey_Window	1	
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	4.10E-09	V^2/GHz
SNR_TX	32.5	dB
R_LM	0.95	

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 8.4e-4 1.1e-4]	2.75 dB /in at 56G
package_tl_tau	6.14E-03	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm
Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 6.44084e-4 3.6036e-05]*	1.5 db/in @ 56G
board_tl_tau	*5.790E-03*	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	*125*	mm
z_bp (NEXT)	*0*	mm
z_bp (FEXT)	*125*	mm
z_bp (RX)	*0*	mm
C_0	[0.2e-4 0]	nF
C_1	[0.2e-4 0]	nF
Include PCB	**0**	**logical**
Seletions (rectangle, gaussian,dual_rayleigh,triangle		
Histogram_Window_Weight	gaussian	selection
Qr	*0.02*	UI
ICN parameters		
f_v	0.278	Fb
f_f	0.278	Fb
f_n	0.278	Fb
f_2	79.688	GHz
A_ft	0.450	V
A_nt	0.450	V
Floating Tap Control		
N_bg	6	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	64	UI span for floating taps
bmaxg	0.2	max DFE value for floati
B_float_RSS_MAX	0.1	rss tail tap limit
N_tail_start	9	(UI) start of tail taps limi
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V

C2M Host Configuration Base for Liav PKG

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 0 0]	nF	[TX RX]
L_s	[.12 .15 .14; 0 0 0]	nH	[TX RX]
C_b	[.3e-4 0]	nF	[TX RX]
z_p select	[1 2 3]		[test cases to run]
z_p (TX)	[12 30 45 ; 2 2 2 ; 0.18 0.18 0.18 ; 0.5 0.5 0.5]	mm	[test cases]
z_p (NEXT)	[0 0 0; 0 0 0;0 0 0 ;0 0 0]	mm	[test cases]
z_p (FEXT)	[12 30 45 ; 2 2 2 ; 0.18 0.18 0.18 ; 0.5 0.5 0.5]	mm	[test cases]
z_p (RX)	[0 0 0; 0 0 0;0 0 0 ;0 0 0]	mm	[test cases]
PKG_Tx_FFE_preset	0		
C_p	[0.08e-4 0]	nF	[TX RX]
R_0	50	Ohm	
R_d	[45 45]	Ohm	[TX RX]
A_v	0.408	V	vp/vf=
A_fe	0.408	V	vp/vf=
A_ne	0.608	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.65		min
c(-1)	[-0.2:0.02:0]		[min:step:max]
c(-2)	[0:.02:0.1]		[min:step:max]
c(-3)	[-0.1:.02:0]		[min:step:max]
c(1)	[-0.2:0.02:0]		[min:step:max]
N_b	8	UI	
b_max(1)	**0.85**		As/dffe1
b_max(2..N_b)	**0.15**		As/dfe2..N_b
b_min(1)	**0**		As/dffe1
b_min(2..N_b)	**-0.15**		As/dfe2..N_b
g_DC	[-13:1:0]	dB	[min:step:max]
f_z	42.5	GHz	
f_p1	42.5	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	1.0625	GHz	
Butterworth	1	logical	include in fr
Raised_Cosine	0	logical	include in fr
RC_Start	6.70E+10	Hz	start freq for RCos
RC_end	7.97E+10	Hz	end freq for RCos

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	rdm\Documents\Scratch\results\c2m_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M TP1a	
COM_CONTRIBUTION	0	logical
Operational		
ERL Pass threshold	10	dB
VEC Pass threshold	12.5	db
DER_0	5.00E-05	
T_r	2.35E-03	ns
FORCE_TR	1	logical
Min_VEO_Test	5	mV
PMD_type	C2M	
EH_min	10	Value
EH_max	1000	Value
T_O	50	mUI
samples_for_C2M	100	samples/UI
EW	1	
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	6000	
TDR_Butterworth	1	logical
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	1	
N_bx	8	UI
fixture delay time	[0 0.2e-9]	
Tukey_Window	1	
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	4.10E-09	V^2/GHz
SNR_TX	32.5	dB
R_LM	0.95	

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 0.0017423 0.000517778]	2.75 dB /in at 56G
package_tl_tau	6.42E-03	ns/mm
package_Z_c	[94 94 ; 76 76; 200 200; 70 70]	Ohm
Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 6.44084e-4 3.6036e-05]*	1.5 db/in @ 56G
board_tl_tau	*5.790E-03*	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	*125*	mm
z_bp (NEXT)	*0*	mm
z_bp (FEXT)	*125*	mm
z_bp (RX)	*0*	mm
C_0	[0.2e-4 0]	nF
C_1	[0.2e-4 0]	nF
Include PCB	**0**	**logical**
Seletions (rectangle, gaussian,dual_rayleigh,triangle		
Histogram_Window_Weight	gaussian	selection
Qr	*0.02*	UI
ICN parameters		
f_v	0.278	Fb
f_f	0.278	Fb
f_n	0.278	Fb
f_2	79.688	GHz
A_ft	0.450	V
A_nt	0.450	V
Floating Tap Control		
N_bg	6	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	120	UI span for floating taps
bmaxg	0.2	max DFE value for floati
B_float_RSS_MAX	0.1	rss tail tap limit
N_tail_start	9	(UI) start of tail taps lim
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V

CA Host Configuration Base for PKG A

Table 93A-1 parameters			2
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	[.3e-4 .3e-4]	nF	[TX RX]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[15 31; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[15 29; 1.8 1.8]	mm	[test cases]
z_p (FEXT)	[15 31; 1.8 1.8]	mm	[test cases]
z_p (RX)	[15 29; 1.8 1.8]	mm	[test cases]
PKG_Tx_FFE_preset	0		
C_p	[0.5e-4 0.5e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.408	V	
A_fe	0.408	V	
A_ne	0.608	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.34:0.02:0]		[min:step:max]
c(-2)	[0:0.02:0.2]		[min:step:max]
c(-3)	[-0.1:0.02: 0]		[min:step:max]
c(1)	[-0.1:0.02:0]		[min:step:max]
N_b	24	UI	
b_max(1)	0.85		
b_max(2..N_b)	0.3		
b_min(1)	-0.85		
b_min(2..N_b)	-0.3		
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	42.5	GHz	
f_p1	42.5	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-8:1:0]		[min:step:max]
f_HP_PZ	1.0625	GHz	
Butterworth	1	logical	1 is an enable
Raised_Cosine	0	logical	1 is an enable
RC_start	6.70E+10	Hz	Begin Tukey range
RC_end	8.00E+10	Hz	End of Tukey range

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\200G_kR_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	R200_eval	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	10.5	dB
DER_0	5.00E-04	
T_r	0.00329	ns
FORCE_TR	1	logical
Local Search	2	
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	6000	
beta_x	0	
rho_x	0.618	
fixture delay time	[0 0]	[port1 port2]
TDR_W_TXPKG	0	
N_bx	36	UI
Z_t	50	ohm
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	4.10E-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 8.4e-4 1.1e-4]	2.75 dB /in at 56G
package_tl_tau	6.14E-03	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 6.44084e-4 3.6036e-05]	1.5 dbpi at 56G
board_tl_tau	0.00579	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	40	mm
z_bp (NEXT)	40	mm
z_bp (FEXT)	40	mm
z_bp (RX)	40	mm
C_0	[0.2e-4]	nF
C_1	[0.1e-4]	nF
Include PCB	0	**logical**
Floating Tap Control		
N_bg	6	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	120	UI span for floating taps
bmaxg	0.2	max DFE value for floating taps
B_float_RSS_MAX	0.2	rss tail tap limit
N_tail_start	25	(UI) start of tail taps limit
ICN parameters		
f_v	0.676	*Fb
f_f	0.676	*Fb
f_n	0.676	*Fb
f_2	79.688	GHz
A_ft	0.600	V
A_nt	**0.600**	V

CA Host Configuration Base for PKG B

Table 93A-1 parameters			2
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	[.3e-4 .3e-4]	nF	[TX RX]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[12 31 ; 2 2 ; 0.18 0.18 ; 0.5 0.5]	mm	[test cases]
z_p (NEXT)	[12 29 ; 2 2 ; 0.18 0.18 ; 0.5 0.5]	mm	[test cases]
z_p (FEXT)	[12 31 ; 2 2 ; 0.18 0.18 ; 0.5 0.5]	mm	[test cases]
z_p (RX)	[12 29 ; 2 2 ; 0.18 0.18 ; 0.5 0.5]	mm	[test cases]
PKG_Tx_FFE_preset	0		
C_p	[0.08e-4 0.08e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[45 45]	Ohm	[TX RX]
A_v	0.408	V	
A_fe	0.408	V	
A_ne	0.608	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.34:0.02:0]		[min:step:max]
c(-2)	[0:0.02:0.2]		[min:step:max]
c(-3)	[-0.1:0.02: 0]		[min:step:max]
c(1)	[-0.1:0.02:0]		[min:step:max]
N_b	24	UI	
b_max(1)	0.85		
b_max(2..N_b)	0.3		
b_min(1)	-0.85		
b_min(2..N_b)	-0.3		
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	42.5	GHz	
f_p1	42.5	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-8:1:0]		[min:step:max]
f_HP_PZ	1.0625	GHz	
Butterworth	1	logical	include in fr
Raised_Cosine	0	logical	include in fr
RC_Start	6.70E+10	Hz	start freq for RCos
RC_end	8.00E+10	Hz	end freq for RCos

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\200G_kR_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	R200_eval	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	10.5	dB
DER_0	5.00E-04	
T_r	0.00329	ns
FORCE_TR	1	logical
Local Search	2	
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	6000	
beta_x	0	
rho_x	0.618	
fixture delay time	[0 0]	[port1 port2]
TDR_W_TXPKG	0	
N_bx	36	UI
Z_t	50	ohm
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	4.10E-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 0.0017423 0.000517778]	2.75 dB /in at 56G
package_tl_tau	6.42E-03	ns/mm
package_Z_c	[94 94 ; 76 76; 200 200; 70 70]	Ohm
Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	[0 6.44084e-4 3.6036e-05]	1.5 dbpi at 56G
board_tl_tau	0.00579	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	40	mm
z_bp (NEXT)	40	mm
z_bp (FEXT)	40	mm
z_bp (RX)	40	mm
C_0	[0.2e-4]	nF
C_1	[0.1e-4]	nF
Include PCB	0	**logical**
Floating Tap Control		
N_bg	6	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	120	UI span for floating taps
bmaxg	0.2	max DFE value for floating taps
B_float_RSS_MAX	0.2	rss tail tap limit
N_tail_start	25	(UI) start of tail taps limit
ICN parameters		
f_v	0.676	*Fb
f_f	0.676	*Fb
f_n	0.676	*Fb
f_2	79.688	GHz
A_ft	0.600	V
A_nt	**0.600**	V