CR V_{min} and V_f Baseline Decisions

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September 2019
IEEE 802.3 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Task Force Interim Meeting
Indianapolis, IN, USA

Agenda

- Review Host Transmitter parameters
- Review V_f and P_{max}
- Details on linear fit parameters
- Max host loss channel with a mated test fixture (MTF) and COM cable assembly (CA) PCB adder
- V_f and P_{max} for posted C2M channels with IL < 12 dB
- Summary, choices, and recommendation

Review: Parameters we are looking to specify

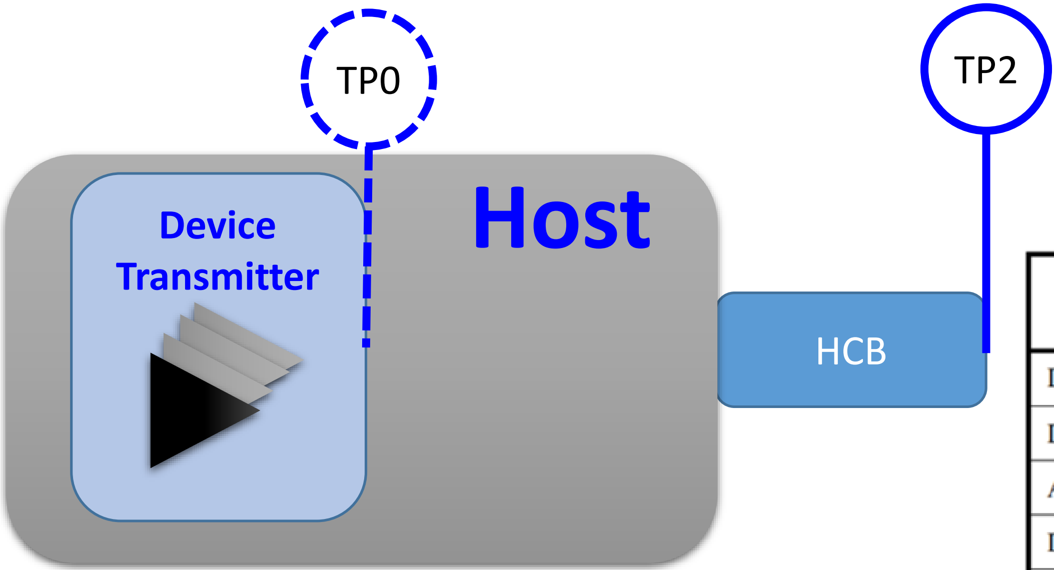
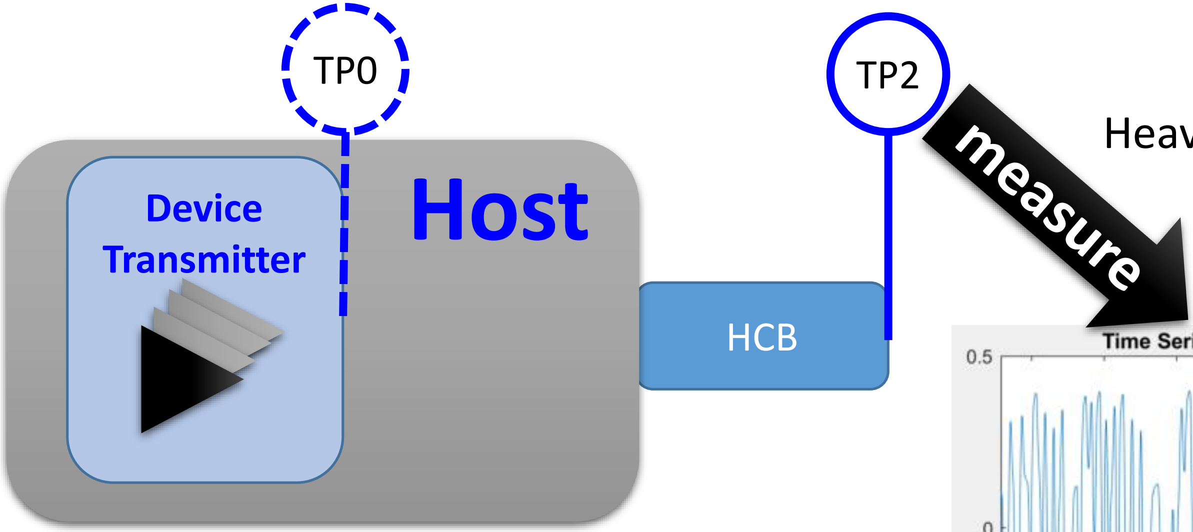


Table 136–11—Summary of transmitter specifications at TP2

Parameter	Subclause reference	Value	Units
Differential pk-pk output voltage (max.) with Tx disabled[a]	93.8.1.3	30	mV
DC common-mode voltage (max.)[a]	93.8.1.3	1.9	V
AC common-mode RMS output voltage, v_{cmi} (max.)[a]	93.8.1.3	30	mV
Differential pk-pk voltage, v_{di} (max.)[a]	93.8.1.3	1200	mV
Effective return loss (ERL) (min.)	136.9.3.4	See Equation (136–6)	dB
Common-mode to differential mode output return loss (min.)	92.8.3.3	See Equation (92–2)	dB
Common-mode to common-mode output return loss (min.)	92.8.3.4	See Equation (92–3)	dB
Transmitter steady-state voltage, v_f (min.) Transmitter steady-state voltage, v_f (max.)	136.9.3.1.2	0.354 0.6	V
Linear fit pulse peak (min.)	136.9.3.1.2	$0.49 \times v_f$	V
Level separation mismatch ratio R_{LM} (min.)	120D.3.1.2	0.95	—

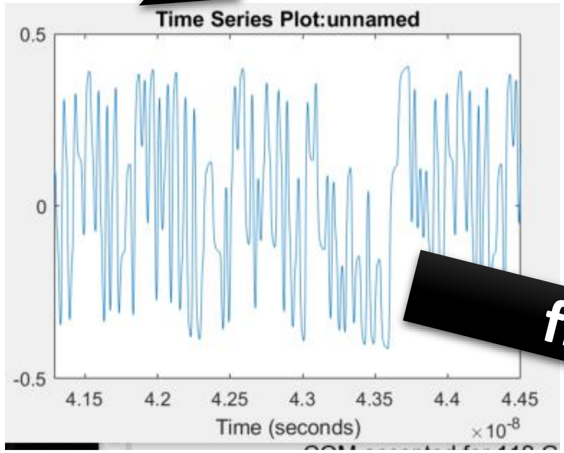
We going after
V_f and the ratio of P_{max}/V_f

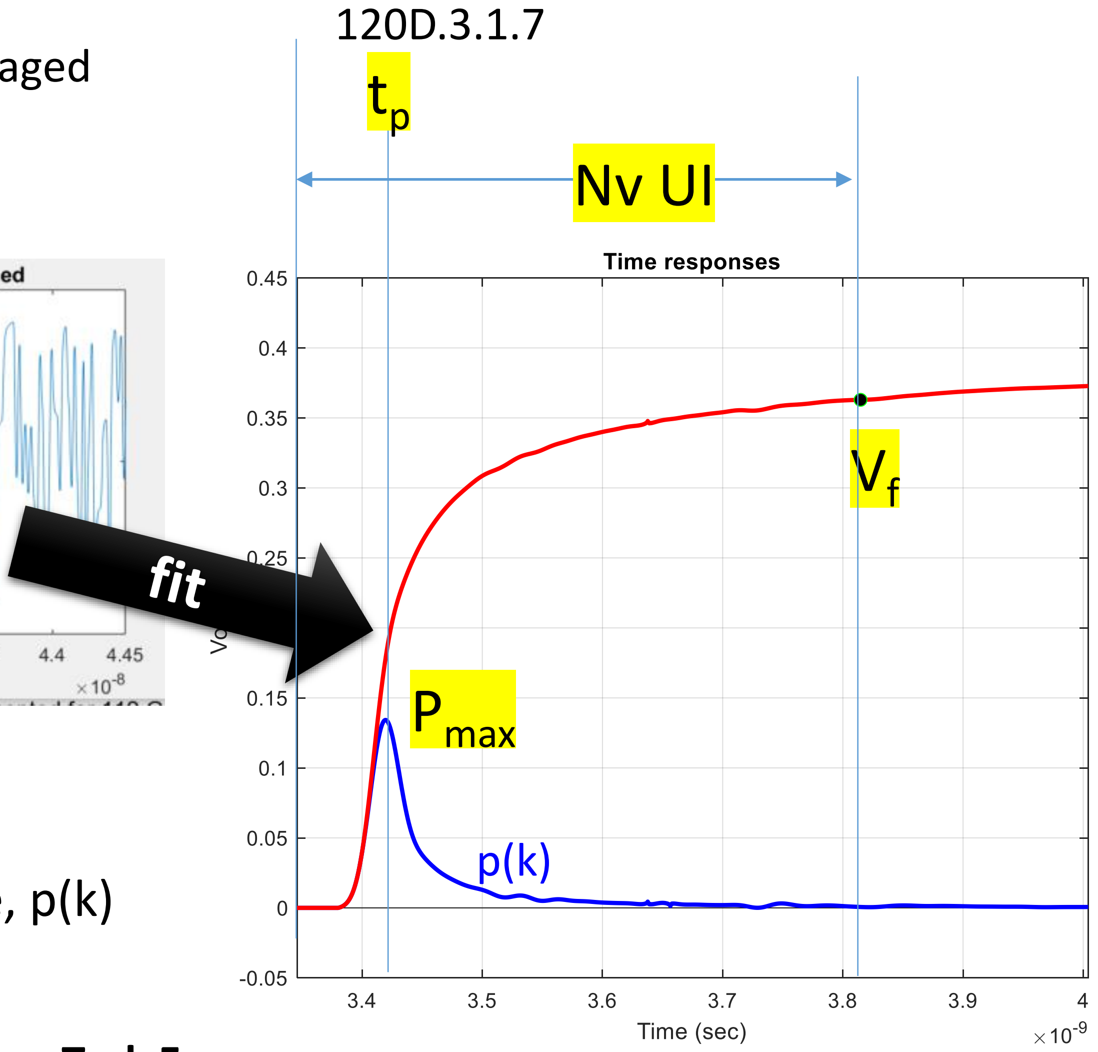
Review: How we find V_f and P_{max}



All transmitting QPRBS13

Heavily averaged





V_f is the Transmitter steady-state-voltage
p_{max} is the Linear fit pulse peak
N_v is the number of UI from the beginning of the fitted pulse, p(k)
T_p is time sample where $p(k) = p_{max}$

First update linear fit

- Refer to clause "*136.9.3.1 Transmitter output waveform*"
  - Change k = -2 to 1 to k = -3 to 1

136.9.3.1 Transmitter output waveform

The transmit function includes programmable equalization to compensate for the frequency-dependent loss of the channel and facilitate data recovery at the receiver. The functional model for the transmit equalizer on each lane is the four-tap transversal filter shown in Figure 136–10.

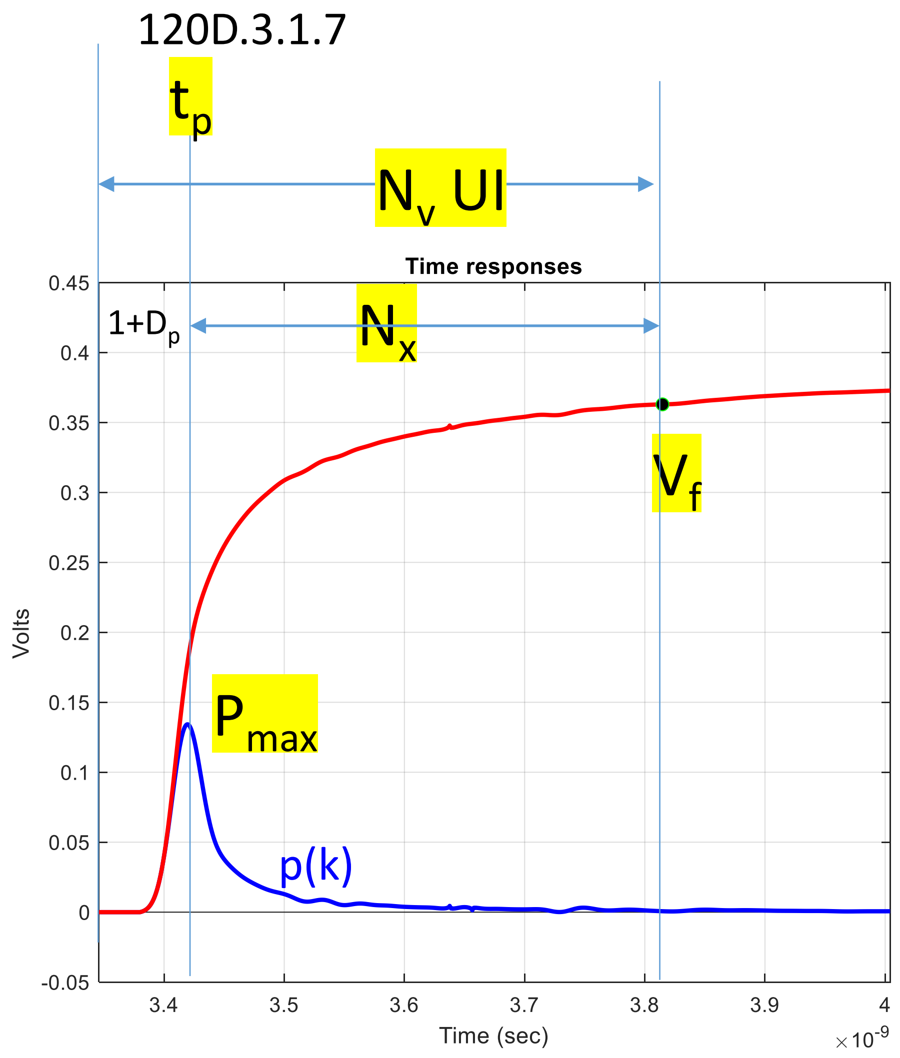
The state of the transmit equalizer and hence the transmitted output waveform may be manipulated via the PMD control function defined in 136.8.11 or via the management interface. The transmit function responds to a set of commands issued by the link partner's receive function and conveyed by a back-channel communications path. This command set includes instructions to increment, decrement, hold, or set to zero a selected coefficient $c(k)$, where $k = -2$ to 1. In addition, it includes commands to set all coefficients to one of three initial conditions.

- Refer to clause "*120D.3.1.3 Linear fit to the measured waveform*"
  - Change D_p= 3 to D_p= 4

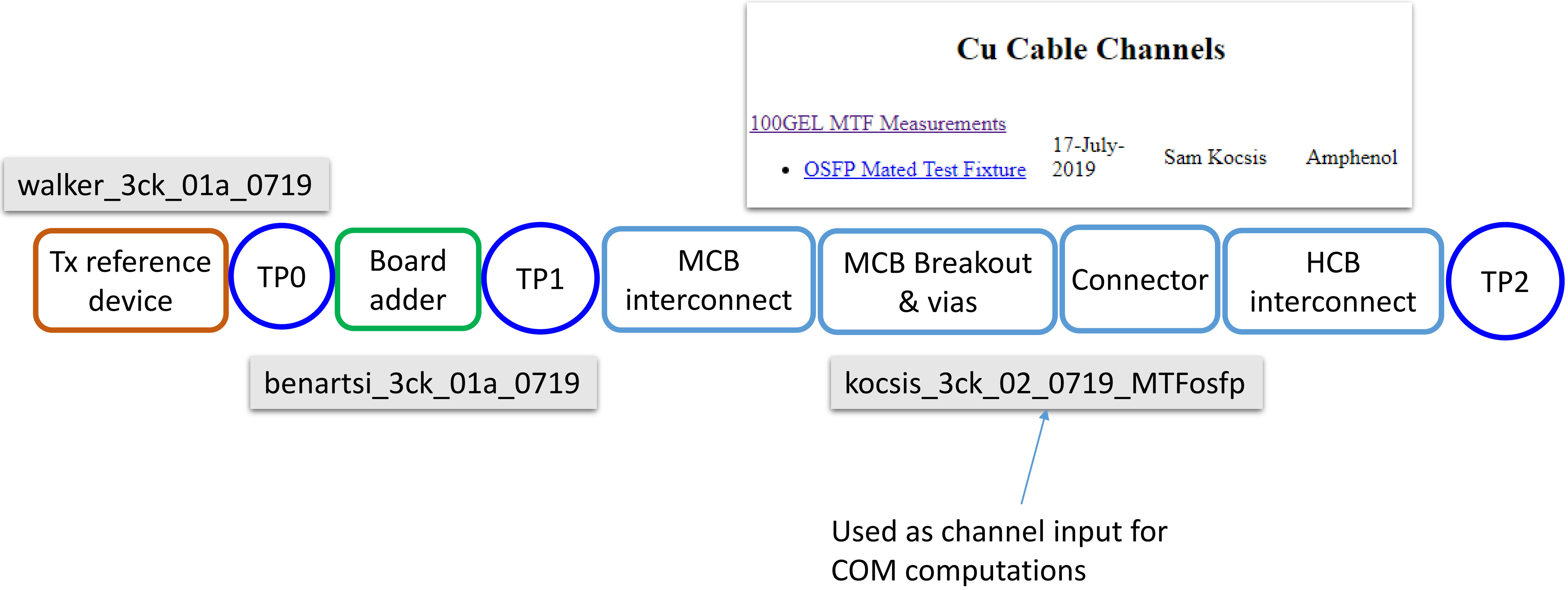
Compute the linear fit pulse response $p(k)$, k=1 to $M \times N_p$, from the captured waveform, as specified in 85.8.3.3.5, with N_p = 200 and D_p = 3, where the aligned symbols $x(n)$ are assigned normalized amplitudes −1, −*ES*, *ES*, and 1 to represent the PAM4 symbol values 0, 1, 2, and 3 respectively. *ES* is defined as $(|ES1| + |ES2|)/2$ where *ES1* and *ES2* are calculated according to 120D.3.1.2.

A closer look at V_f

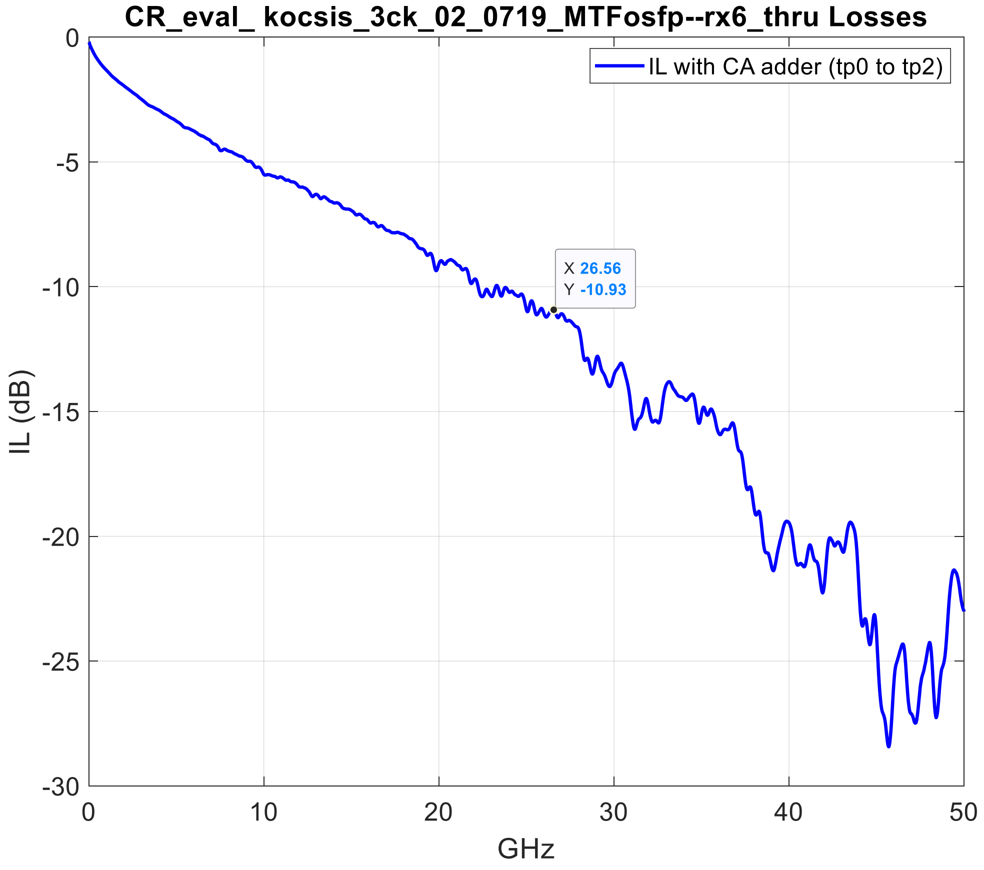
- N_v starts at the index associated with the last precursor tap, D_p
  - For this work $D_p = 3$
- Clause 120D.3.1.3 increased the range of the fit to 200 UI (N_p)
- N_v was 13
  - For Annex 120D, clause 136 and 137
  - N_v was used to compute V_f
- For this work lets define $N_v = D_p + 1 + N_x$
- In the special COM spreadsheet N_b is used to compute V_f so that $N_b = N_x$
- Then $N_v = N_b + D_p + 1 = N_b + 4$

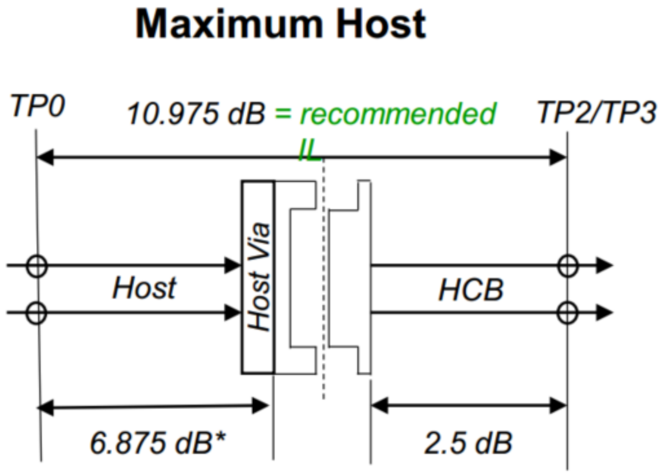


First lets determine V_f and P_{max}/V_f from an MTB plus COM assumptions for a CA



MTF and COM CA Host Adder Insertion Loss is ~ 10.97 dB





Note: The 6.875 dB includes via allowances for BGA and connector footprint

diminico_3ck_cu cable 8-12-19

Special MTF COM spreadsheet for N_b = 9

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 0]	nF	[TX RX]
L_s	[0.12, 0]	nH	[TX RX]
C_b	[0.3e-4 0]	nF	[TX RX]
z_p select	[2]		[test cases to run]
z_p (TX)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[0 0 ; 0 0]	mm	[test cases]
z_p (FEXT)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (RX)	[0 0 ; 0 0]	mm	[test cases]
C_p	[0.87e-4 0]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.415	V	vp/vf=.694
A_fe	0.415	V	vp/vf=.694
A_ne	0.608	V	
L	2		
M	32		
filter and Eq			
f_r	0.6	*fb	
c(0)	0.54		min
c(-1)	0		[min:step:max]
c(-2)	0		[min:step:max]
c(-3)	0		[min:step:max]
c(1)	0		[min:step:max]
N_b	9	UI	
b_max(1)	1		
b_max(2..N_b)	1		
g_DC	0	dB	[min:step:max]
f_z	200	GHz	
f_p1	200	GHz	
f_p2	400	GHz	
g_DC_HP	0		[min:step:max]
f_HP_PZ	0.001	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\100GEL_CR_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	Host_Vf_pmax_	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	10	dB
DER_0	1.00E-04	
T_r	6.16E-06	ns
FORCE_TR	1	logical

TDR and ERL options		
TDR	0	logical
ERL	0	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	600	
beta_x	2.3407E+09	
rho_x	0.16	
fixture delay time	[0 0]	[port1 port2]
TDR_W_TXPKG	0	
N_bx	12	UI
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
Noise, jitter		
sigma_RJ	0	UI
A_DD	0	UI
eta_0	1.00E-15	V^2/GHz
SNR_TX	100	dB
R_LM	1	

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
package_tl_tau	6.141E-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 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)	*0*	mm
z_bp (FEXT)	*0*	mm
z_bp (RX)	*0*	mm
C_0	[0.29e-4 0]	nF
C_1	[0.19e-4 0]	nF
Include PCB	**1**	**logical**

Floating Tap Control		
N_bg	0	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	40	UI span for floating taps
bmaxg	0.2	max DFE value for floating taps

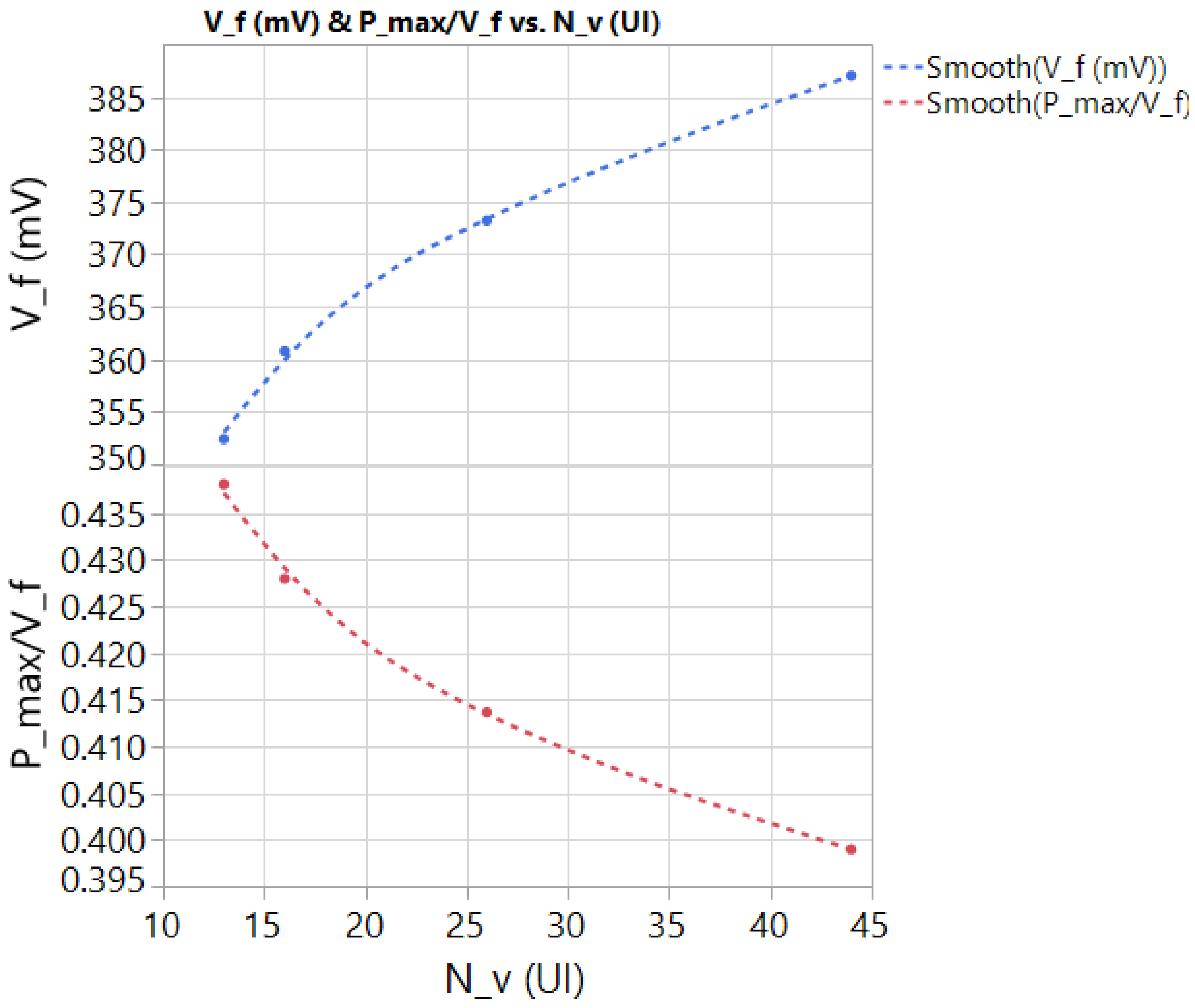
cable assemblies require this for each HCB

ICN parameters (v2.73)		
f_f	12919.296	
f_n	12919.296	
f_2	31.875	
A_ft	0.600	
A_nt	**0.600**	

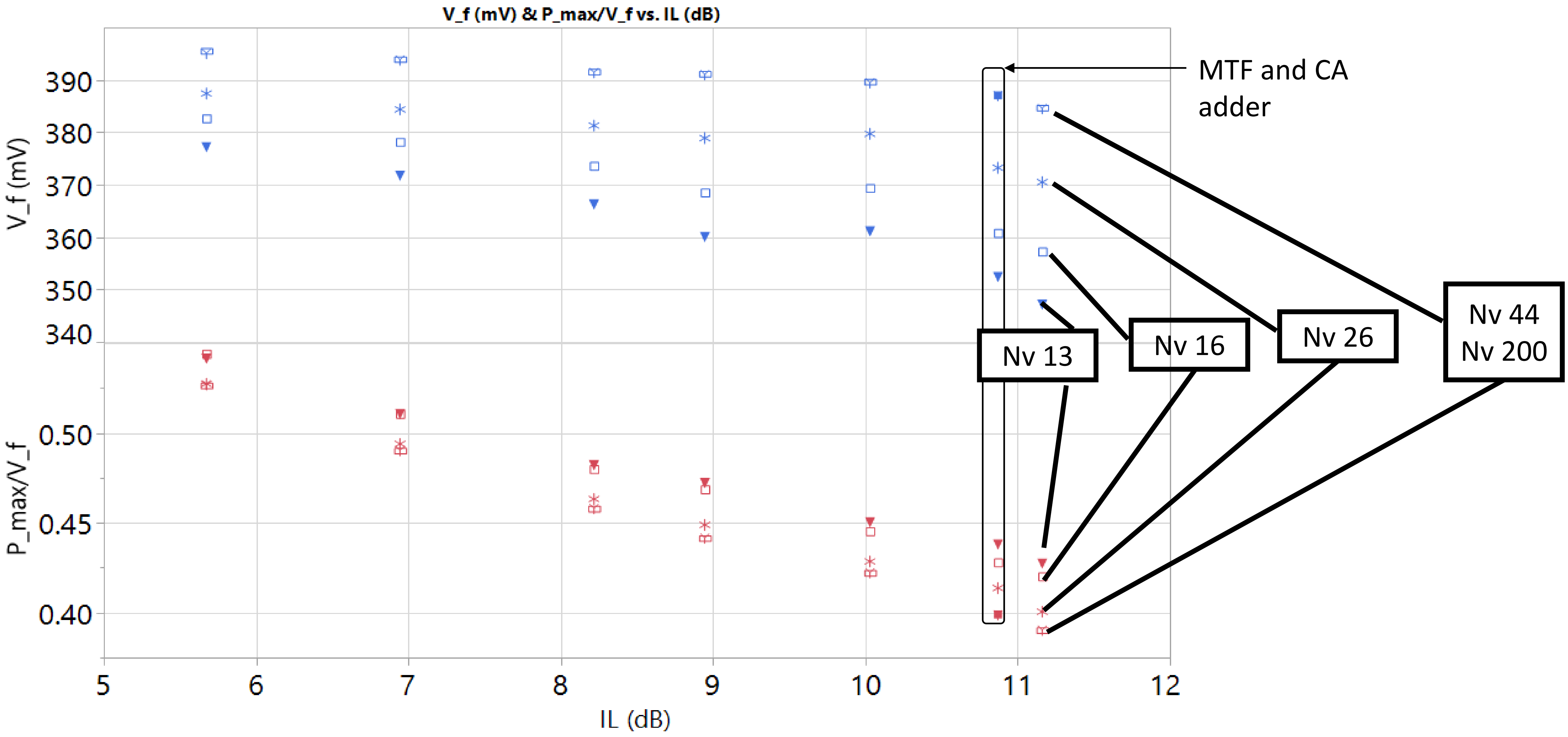
For COM versions later than 2.73

Results for MTF and COM CA adder TP0 – TP2 loss = 10.97 dB

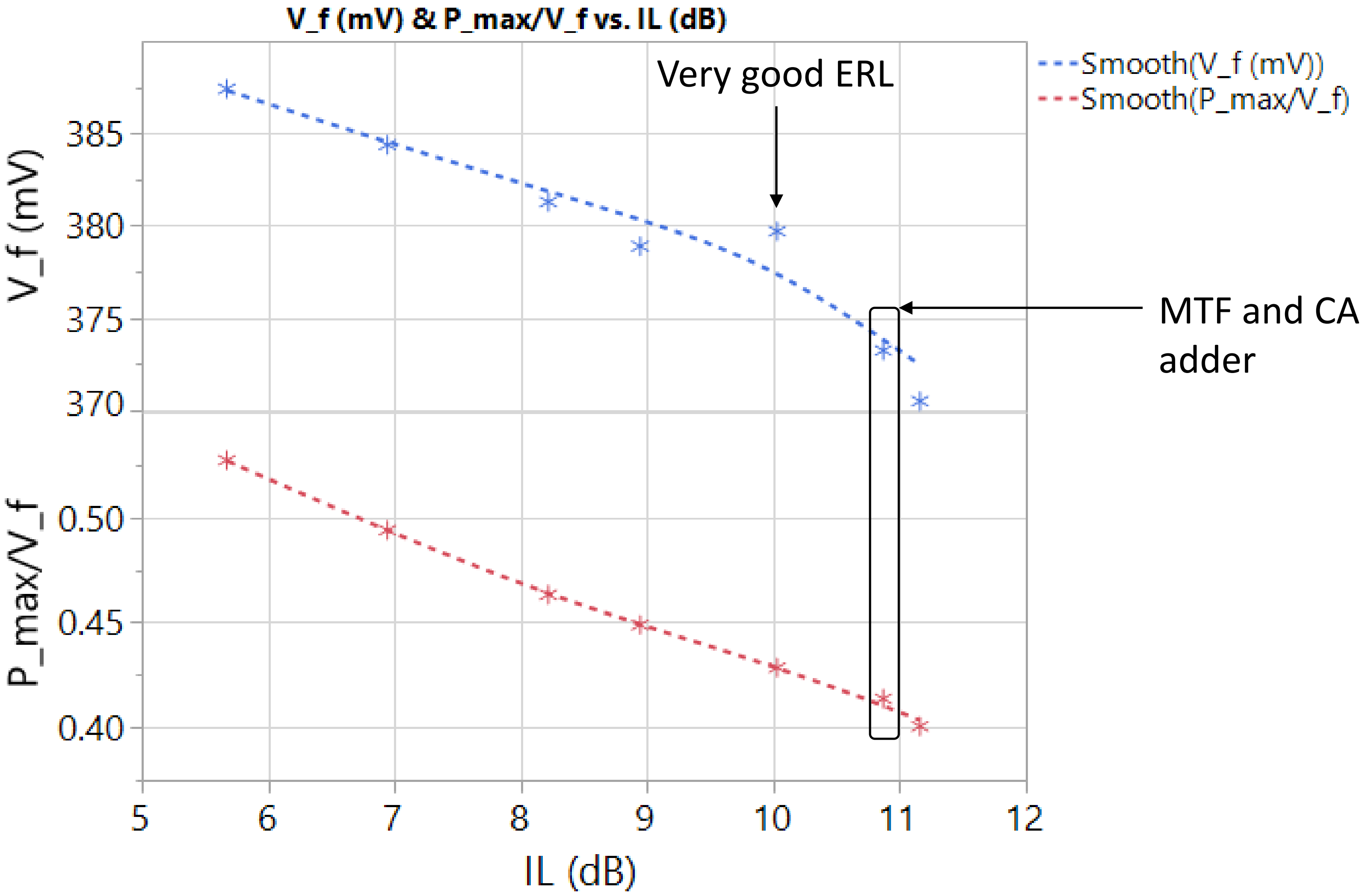
N_v (UI)	N_b (UI)	V_f (mV)	P_max/V_f
13	9	352.45	0.438
16	12	360.82	0.428
26	22	373.25	0.414
44	40	387.05	0.399



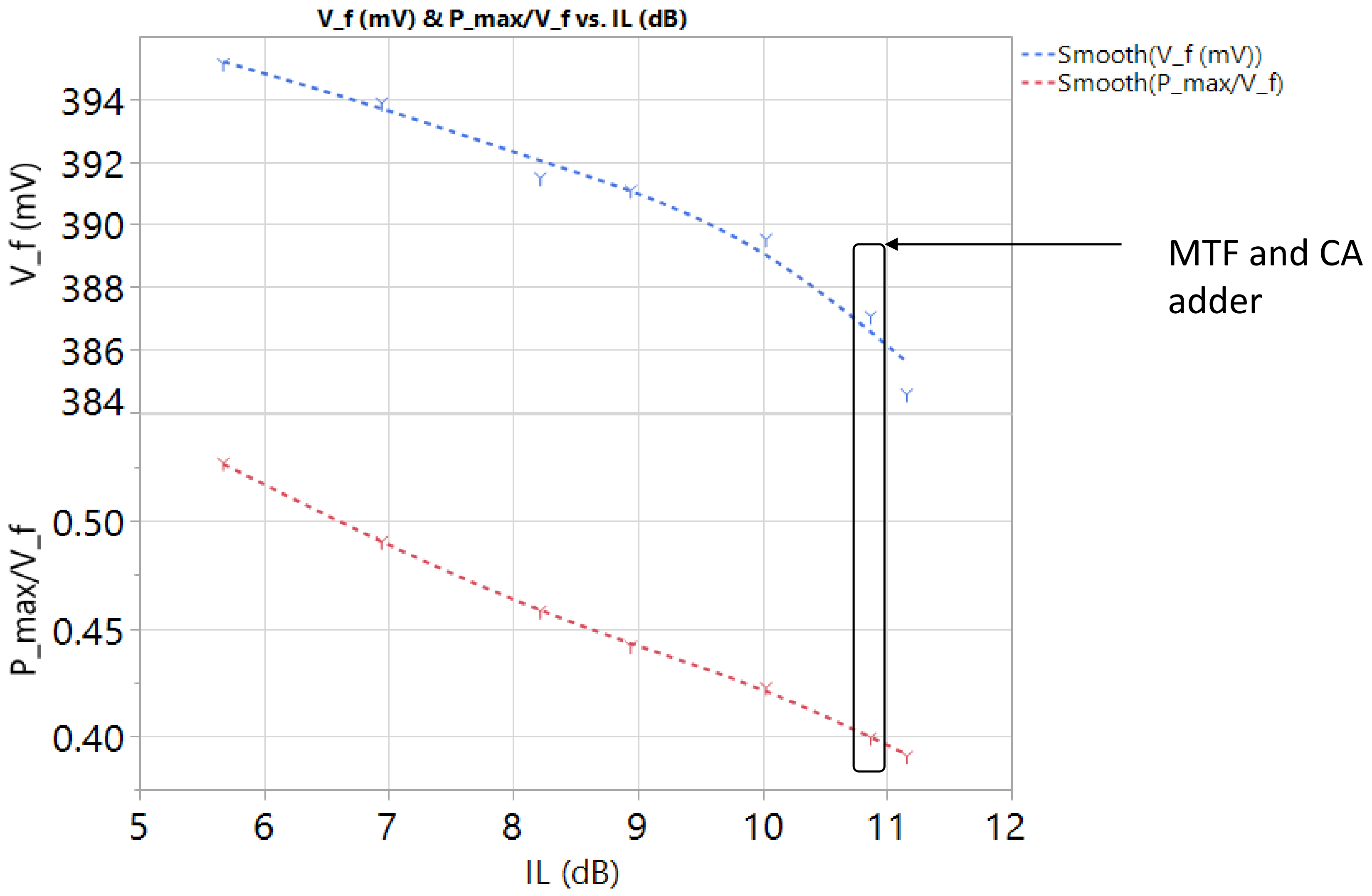
A look at some channels tp0 to tp2 < 12 dB IL



V_f and P_{max} vs IL for N_v=26 suggests margin needed to account for real product return loss variations



V_f and P_{max} vs IL for N_v=200 may be more indicative of true loss



Summary

- There is good agreement between the artificial MTF + COM CA adder and posted C2M channels < 12 dB IL
  - For V_f and P_{max}/V_f
  - The small differences may be attributed to return loss
  - Products will need margin to the ideal MTF + COM CA adder
    - Suggestion: 2 mV less V_f and 2 thousandths less P_{max}/V_f

Choices

- Choice c might be suggested from the doubled baud rate used for 50 G PAM4
- Choice e might be suggested since the fit is using N_v=200. The longer time range of the step response would have better sensitivity to loss.
- Recommend the choice be used for all 100 Gb/s PMDs which use the fitted pulse parameters

	N_v (UI)	N_b (UI)	V_f (mV)	P_max/V_f
a	13	9	350	0.446
b	16	12	359	0.436
c	26	22	371	0.411
d	44	40	385	0.397
e	200	-	387	0.397

Thank You!

Channel Data

channel	IL (dB)	V_f (mV)	P_max/V_f	N_b (UI)	N_v (UI)
'"R7 10dB--100GEL_C2M_10dB_Thru"'	10.03	361.16	0.45	9	13
'"R12 10dB--100GEL_C2M_10dB_thru"'	10.03	361.16	0.45	9	13
'"R15 mellitz_3ck_01_0518_C2M--C2M__Z100_IL9_BC-BOR_N_N_N_THRU"'	8.95	360.11	0.47	9	13
'"R16 mellitz_3ck_01_0518_C2M--C2M__Z100_IL10_WC-BOR_H_L_H_THRU"'	9.96	365.22	0.49	9	13
'"R17 mellitz_3ck_01_0518_C2M--C2M__Z100_IL11p2_BC-BOR_N_N_N_THRU"'	11.16	347.18	0.43	9	13
'"R61 Channel5a_Smaller_Pad_2inch_trace--Channel5_thru_small_pad_2inch"'	5.67	377.25	0.54	9	13
'"R62 Channel5b_Smaller_Pad_3inch_trace--Channel5_thru_small_pad_3inch"'	6.94	371.79	0.51	9	13
'"R63 Channel5c_Smaller_Pad_4inch_trace--Channel5_thru_small_pad_4inch"'	8.22	366.31	0.48	9	13
'"R7 10dB--100GEL_C2M_10dB_Thru"'	10.03	369.41	0.45	12	16
'"R12 10dB--100GEL_C2M_10dB_thru"'	10.03	369.41	0.45	12	16
'"R15 mellitz_3ck_01_0518_C2M--C2M__Z100_IL9_BC-BOR_N_N_N_THRU"'	8.95	368.53	0.47	12	16
'"R16 mellitz_3ck_01_0518_C2M--C2M__Z100_IL10_WC-BOR_H_L_H_THRU"'	9.96	371.62	0.49	12	16
'"R17 mellitz_3ck_01_0518_C2M--C2M__Z100_IL11p2_BC-BOR_N_N_N_THRU"'	11.16	357.29	0.42	12	16
'"R61 Channel5a_Smaller_Pad_2inch_trace--Channel5_thru_small_pad_2inch"'	5.67	382.67	0.54	12	16
'"R62 Channel5b_Smaller_Pad_3inch_trace--Channel5_thru_small_pad_3inch"'	6.94	378.19	0.51	12	16
'"R63 Channel5c_Smaller_Pad_4inch_trace--Channel5_thru_small_pad_4inch"'	8.22	373.64	0.48	12	16
'"R7 10dB--100GEL_C2M_10dB_Thru"'	10.03	379.71	0.43	22	26
'"R12 10dB--100GEL_C2M_10dB_thru"'	10.03	379.71	0.43	22	26
'"R15 mellitz_3ck_01_0518_C2M--C2M__Z100_IL9_BC-BOR_N_N_N_THRU"'	8.95	378.90	0.45	22	26
'"R16 mellitz_3ck_01_0518_C2M--C2M__Z100_IL10_WC-BOR_H_L_H_THRU"'	9.96	379.88	0.47	22	26
'"R17 mellitz_3ck_01_0518_C2M--C2M__Z100_IL11p2_BC-BOR_N_N_N_THRU"'	11.16	370.51	0.40	22	26
'"R61 Channel5a_Smaller_Pad_2inch_trace--Channel5_thru_small_pad_2inch"'	5.67	387.42	0.53	22	26
'"R62 Channel5b_Smaller_Pad_3inch_trace--Channel5_thru_small_pad_3inch"'	6.94	384.39	0.49	22	26
'"R63 Channel5c_Smaller_Pad_4inch_trace--Channel5_thru_small_pad_4inch"'	8.22	381.30	0.46	22	26

Channel Data

channel	IL (dB)	V_f (mV)	P_max/V_f	N_b (UI)	N_v (UI)
'"R7 10dB--100GEL_C2M_10dB_Thru"'	10.03	389.68	0.42	40	44
'"R12 10dB--100GEL_C2M_10dB_thru"'	10.03	389.68	0.42	40	44
'"R15 mellitz_3ck_01_0518_C2M--C2M__Z100_IL9_BC-BOR_N_N_N_THRU"'	8.95	391.20	0.44	40	44
'"R16 mellitz_3ck_01_0518_C2M--C2M__Z100_IL10_WC-BOR_H_L_H_THRU"'	9.96	392.71	0.46	40	44
'"R17 mellitz_3ck_01_0518_C2M--C2M__Z100_IL11p2_BC-BOR_N_N_N_THRU"'	11.16	384.72	0.39	40	44
'"R61 Channel5a_Smaller_Pad_2inch_trace--Channel5_thru_small_pad_2inch"'	5.67	395.56	0.53	40	44
'"R62 Channel5b_Smaller_Pad_3inch_trace--Channel5_thru_small_pad_3inch"'	6.94	393.98	0.49	40	44
'"R63 Channel5c_Smaller_Pad_4inch_trace--Channel5_thru_small_pad_4inch"'	8.22	391.59	0.46	40	44
MTF and CA adder	10.87	352.45	0.44	9	13
MTF and CA adder	10.87	360.82	0.43	12	16
MTF and CA adder	10.87	375.04	0.41	21	25
MTF and CA adder	10.87	373.25	0.41	22	26
MTF and CA adder	10.87	387.05	0.40	40	44
MTF and CA adder	10.87	387.05	0.40	200	204
'"R7 10dB--100GEL_C2M_10dB_Thru"'	10.03	389.52	0.42	200	204
'"R12 10dB--100GEL_C2M_10dB_thru"'	10.03	389.52	0.42	200	204
'"R15 mellitz_3ck_01_0518_C2M--C2M__Z100_IL9_BC-BOR_N_N_N_THRU"'	8.95	391.07	0.44	200	204
'"R16 mellitz_3ck_01_0518_C2M--C2M__Z100_IL10_WC-BOR_H_L_H_THRU"'	9.96	392.58	0.46	200	204
'"R17 mellitz_3ck_01_0518_C2M--C2M__Z100_IL11p2_BC-BOR_N_N_N_THRU"'	11.16	384.57	0.39	200	204
'"R61 Channel5a_Smaller_Pad_2inch_trace--Channel5_thru_small_pad_2inch"'	5.67	395.12	0.53	200	204
'"R62 Channel5b_Smaller_Pad_3inch_trace--Channel5_thru_small_pad_3inch"'	6.94	393.87	0.49	200	204
'"R63 Channel5c_Smaller_Pad_4inch_trace--Channel5_thru_small_pad_4inch"'	8.22	391.47	0.46	200	204