Towards a 200Gbps/Lane High-Loss AUI Baseline Consensus – Status Report

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IEEE P802.3dj Task Force

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Contributor

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Outline

- Background and Introduction
- BER Status Recap
- Loss Target Update
- Reference Receiver Consideration
- Summary

Background and Introduction

- This presentation will update high-loss AUI baseline directions with adopted DER_0 value, as well as comparing technical characteristics between C2C and C2M in order to proceed
  - BER budget partitioning
  - Loss target consensus building
  - Channel agreement
  - Decision on MLSE
- Goals of this presentation
  - Step towards narrowing the group's focus so that the AUI baseline proposals can proceed
  - Not debating the high-loss AUI specification parameters at this time

BER Status Recap

- **BER related decision made in motions_3cwdfdj_2305**

> **Motion #8**
>
> Move to:
> - adopt a DER0 value of 2.67e-5 (equivalent to measured BER of 4e-5 with precoding ON) as the total allocation for higher-loss AUIs within a PHY (BER division between C2C and C2M as well as the measurement method to be determined later)
>
> M: Adee Ran
> S: Kishore Kota
> Technical (>=75%) Procedural (>50%)
> 802.3 voters only
> Results: Y: 75, N: 3, A: 20 passed 10:33 a.m.

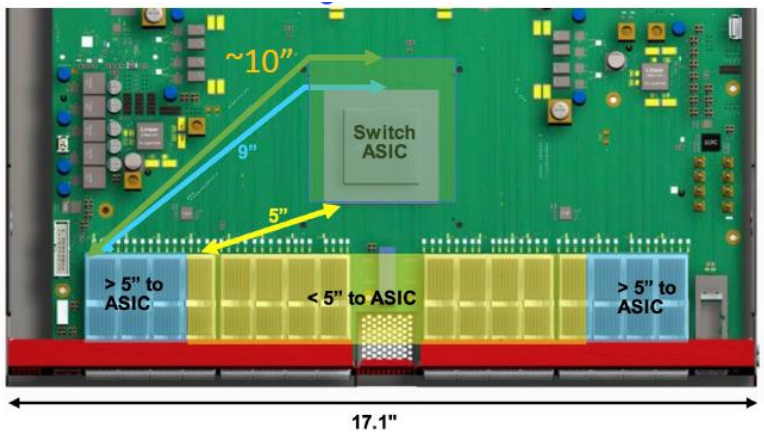
- **Can all module cages accommodate host budgets without retimers?**
- **Is there any other DER_0 combinations?**

- **200Gbps/lane AUI DER_0 target options**
  - **C2M and C2C AUI DER_0 1.33e-5 → Comparable interface complexity between C2M and C2C**
  - **C2M and C2C AUI DER_0 2.67e-5 → ASIC-CDR links should use retimerless systems per Type I PHY**

Loss Target Update

- **C2M bump-to-bump loss have been updated in oif2023.210**
  - **Considering high radix system with PCB implementation**
  - **Worst case loss is a little over 36dB**
  - **2/3 of channels have a loss less than 32dB**
- **C2C loss budget summarized in lit_3dj_01a_2305**
  - **mellitz_3dj_elec_01_230504 contributed mezzanine channels of TP0-TP5 loss ~20.xdB with a total length of 260mm**
  - **Total package loss at two sides ~12dB**
    - 6-8dB package losses proposed in benartsi_3df_01a_2211, ghiasi_3df_01_220927, and li_3dj_02_2305
  - **Bump-to-bump loss ~32dB**

Source: stone_3ck_01a_0518 & ghiasi_3df_01_2211



- **Do we have consensus on 32dB bump-to-bump IL budget for high-loss C2M and C2C?**

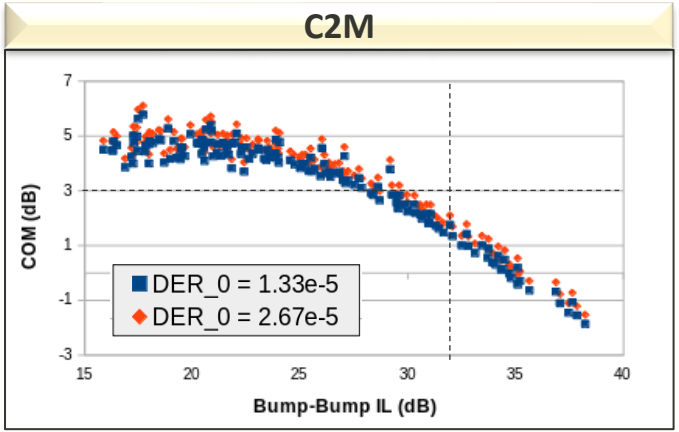
Reference RX Consideration

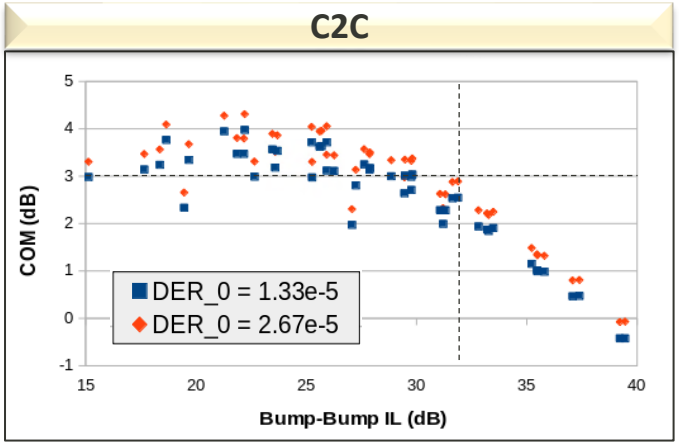
- COM 4.0 used, test channels and spreadsheet in appendix

Parameter	802.3ck C2M	802.3ck C2C	802.3ck CR	802.3ck KR	Exploratory of 802.3dj AUI
DER_0	1E-5	1E-5	1E-4	1E-4	**1.33E-5/2.67E-5**
SNR_TX	32.5	33	32.5	33	33
R_LM	0.95	0.95	0.95	0.95	0.95
TxFIR Length	4 (2 pre)	5 (3 pre)	5 (3 pre)	5 (3 pre)	6 (4 pre)
eta_0	4.10E-08	2E-08	9E-09	8.2E-09	8.2E-09
N_b	4	6	12	12	24
N_bg	0	0	3	3	6
N_bf	-	-	3	3	3
N_f	-	-	40	40	60
MLSE	-	-	-	-	**0**

- For 32dB links, EQ length of 24+18 and eta_0 of 8.2e-9 are several time power-consuming than the practical receiver
- MLSE is needed to make most of the channels work, regardless of DER_0 target

- Are those channels representative and qualified?
- Should we adopt MLSE as part of ref RX for high-loss AUI?

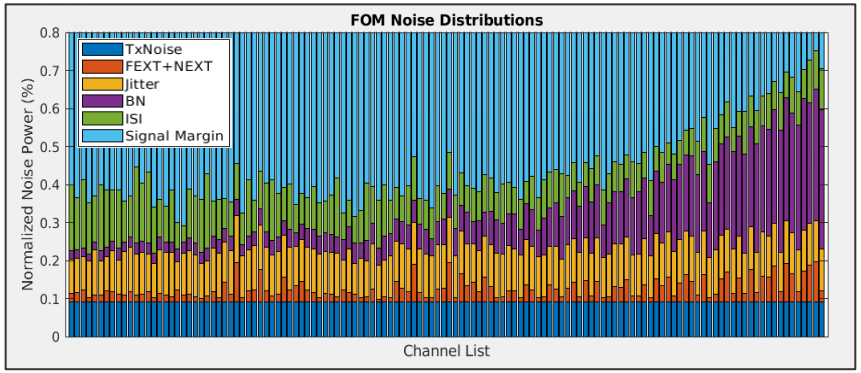


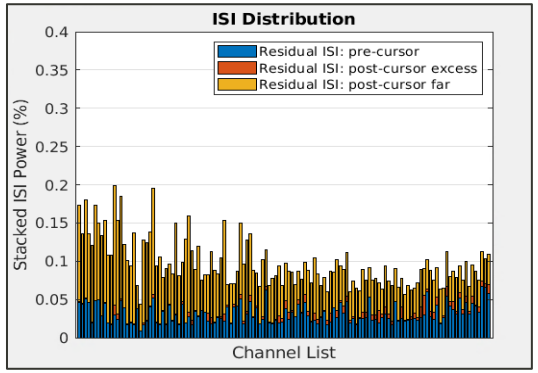


Noise Distribution

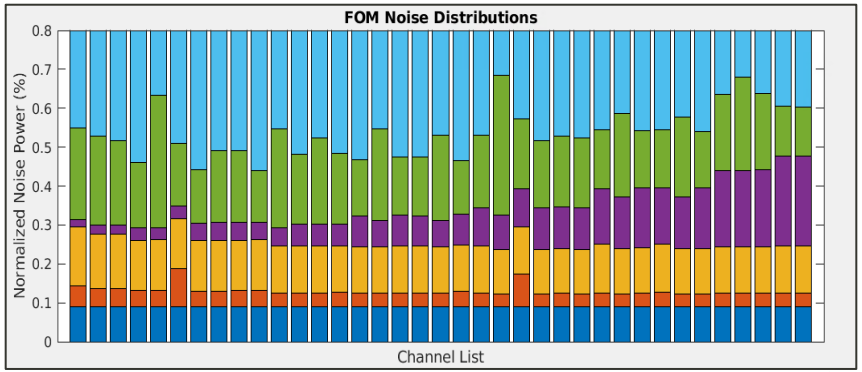
- Medium loss AUI will suffer from reflections
- High loss AUI will suffer from signal swing reduction and noise enhancement
- C2C reflection is generally worse than that of C2M

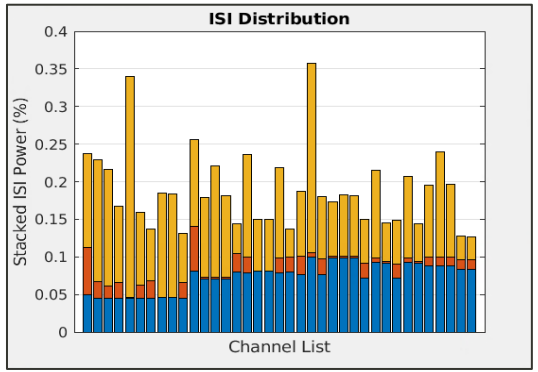
C2M





C2C



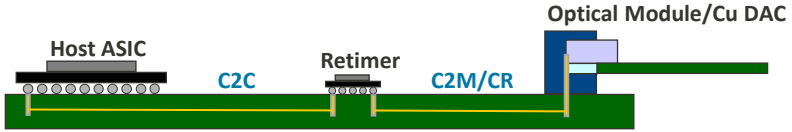


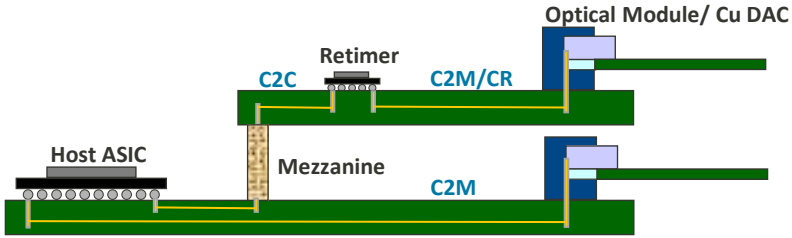
Channel sorted by IL

*DER_0 = 1.33e-5
*Bump-to-bump IL <= 32dB

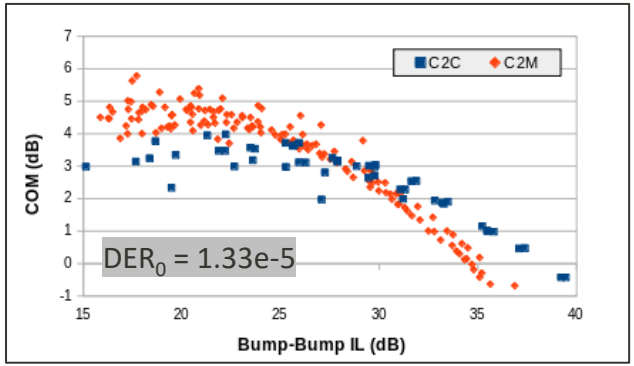
C2M vs C2C Channel Characteristic

- Different constraints between paddle card for module and the mezzanine card for C2C
- Mezzanine connector is more configurable than a standardized form factor OSFP
- C2C could have two extra vias
- Receiver package assumption
  - C2M channels do not have much reflections near the module device
  - HCB is assumed with ideal T-line loss, instead of actual module design





	C2M	C2C
z_p (TX)	[15 30; 1 1; 1 1; 0.5 0.5]	[12 31; 1 1; 1 1; 0.5 0.5]
z_p (NEXT)	**[8 8; 0 0; 0 0; 0 0]**	**[11 29; 1 1; 1 1; 0.5 0.5]**
z_p (FEXT)	[15 30; 1 1; 1 1; 0.5 0.5]	[12 31; 1 1; 1 1; 0.5 0.5]
z_p (RX)	**[8 8; 0 0; 0 0; 0 0]**	**[11 29; 1 1; 1 1; 0.5 0.5]**



- **Do we agree on channels and endpoint assumptions**

Summary

- **Loss target for 200Gbps/Lane high loss C2M have been updated from 36dB to 32dB based on channel optimization**
- **Recommend that 802.3dj C2C shall address the bump-to-bump loss of 32dB**
- **MLSE is required to make most of the available channels work regardless of DER_0 target**
- **For an AUI baseline proposal we need to agree on channels and endpoint assumptions**
- **Next step is to evaluate AUI baseline with updated channels and a proper receiver impairment/margin allocation**
  - **Plan to have AUI baseline proposal for the July 2023 plenary session**
  - **Please reach out to us to get involved in the suggested directions of DER_0 target, loss target, and reference receiver**

Appendix

Channel List

Application	Contribution
C2M	akinwale_3df_01_2209
	akinwale_3df_02_2209
	akinwale_3df_03_2209
	rabinovich_3df_01_2209
	rabinovich_3df_02_2209
	rabinovich_3dj_02_230116
	rabinovich_3dj_03_230116
	Shanbhag_3dj_03_2305
C2C	mellitz_3dj_elec_01_230504

Example COM Configuration for 200Gbps/L C2M

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]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[15 30; 1 1 ; 1 1; 0.5 0.5]	mm	[test cases]
z_p (NEXT)	[8 8; 0 0 ; 0 0; 0 0]	mm	[test cases]
z_p (FEXT)	[15 30; 1 1 ; 1 1; 0.5 0.5]	mm	[test cases]
z_p (RX)	[8 8; 0 0 ; 0 0; 0 0]	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	0.413	V	vp/vf=
A_fe	0.413	V	vp/vf=
A_ne	0.45	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.54		min
c(-1)	[-0.4:0.02:0]		[min:step:max]
c(-2)	[0:.02:0.2]		[min:step:max]
c(-3)	[-0.04:.02:0]		[min:step:max]
c(-4)	[0:.02:0.02]		[min:step:max]
c(1)	[-0.12:0.02:0.04]		[min:step:max]
N_b	24	UI	
b_max(1)	0.85		As/dffe1
b_max(2..N_b)	[0.3 0.2*ones(1,22)]		As/dfe2..N_b
b_min(1)	0		As/dffe1
b_min(2..N_b)	[-0.2 -0.2*ones(1,22)]		As/dfe2..N_b
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	[-6:1:0]		[min:step:max]
f_HP_PZ	1.328125	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	0	logical
DISPLAY_WINDOW	0	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\CAKR_[date]\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	CAKR_RCos_eyal_	
COM_CONTRIBUTION	0	logical
Operational		
ERL Pass threshold	9.7	dB
COM Pass threshold	3	db
DER_0	1.33E-05	
T_r	4.00E-03	ns
FORCE_TR	1	logical
PMD_type	C2C	
EW	1	
TDR and ERL options		logical
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	ns
TR_TDR	0.01	
N	2000	logical
TDR_Butterworth	1	
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	1	UI
N_bx	0	
fixture delay time	[0 0]	
Tukey_Window	1	
Noise, jitter		UI
sigma_RJ	0.01	UI
A_DD	0.02	V^2/GHz
eta_0	8.20E-09	dB
SNR_TX	33	
R_LM	0.95	
Enforce Causality	1	
S-parameter magnitude extrapolation policy	trend_to_DC	
Filter: RxFFE		
ffe_pre_tap_len	0	UI
ffe_post_tap_len	0	UI
ffe_tap_step_size	0	
ffe_main_cursor_min	0.7	
ffe_pre_tap1_max	0.7	
ffe_post_tap1_max	0.7	
ffe_tapn_max	0.7	
ffe_backoff	0	

Table 93A-3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 0.0008455 0.000340225]	
package_tl_tau	0.00644805	ns/mm
package_Z_c	[92 92 ; 70 70; 80 80; 100 100]	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	0.594	Fb
f_f	0.594	Fb
f_n	0.594	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	80	UI span for floating taps
bmaxg	0.2	max DFE value for floating taps
MLSE	1	logical
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V

Example COM Configuration for 200Gbps/L C2C

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]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[13 31; 1 1 ; 1 1 ; 0.5 0.5]	mm	[test cases]
z_p (NEXT)	[11 29; 1 1 ; 1 1 ; 0.5 0.5]	mm	[test cases]
z_p (FEXT)	[13 31; 1 1 ; 1 1 ; 0.5 0.5]	mm	[test cases]
z_p (RX)	[11 29; 1 1 ; 1 1 ; 0.5 0.5]	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	0.413	V	vp/vf=
A_fe	0.413	V	vp/vf=
A_ne	0.45	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.54		min
c(-1)	[-0.4:0.02:0]		[min:step:max]
c(-2)	[0:.02:0.2]		[min:step:max]
c(-3)	[-0.04:.02:0]		[min:step:max]
c(-4)	[0:.02:0.02]		[min:step:max]
c(1)	[-0.12:0.02:0.04]		[min:step:max]
N_b	24	UI	
b_max(1)	0.85		As/dffe1
b_max(2..N_b)	[0.3 0.2*ones(1,22)]		As/dfe2..N_b
b_min(1)	0		As/dffe1
b_min(2..N_b)	[-0.2 -0.2*ones(1,22)]		As/dfe2..N_b
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	[-6:1:0]		[min:step:max]
f_HP_PZ	1.328125	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	0	logical
DISPLAY_WINDOW	0	logical
CSV_REPORT	0	logical
RESULT_DIR	.\results\CAKR_[date]\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	CAKR_RCos_eval_	
COM_CONTRIBUTION	0	logical
Operational		
ERL Pass threshold	9.7	dB
COM Pass threshold	3	db
DER_0	1.33E-05	
T_r	4.00E-03	ns
FORCE_TR	1	logical
PMD_type	C2C	
EW	1	
TDR and ERL options		logical
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	ns
TR_TDR	0.01	
N	2000	logical
TDR_Butterworth	1	
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	0	UI
N_bx	0	
fixture delay time	[0 0]	
Tukey_Window	1	
Noise, jitter		UI
sigma_RJ	0.01	UI
A_DD	0.02	V^2/GHz
eta_0	8.20E-09	dB
SNR_TX	33	
R_LM	0.95	

Enforce Causality	1	
S-parameter magnitude extrapolation policy	trend_to_DC	

Filter: RxFFE		
ffe_pre_tap_len	0	UI
ffe_post_tap_len	0	UI
ffe_tap_step_size	0	
ffe_main_cursor_min	0.7	
ffe_pre_tap1_max	0.7	
ffe_post_tap1_max	0.7	
ffe_tapn_max	0.7	
ffe_backoff	0	

Table 93A-3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 0.0008455 0.000340225]	
package_tl_tau	0.00644805	ns/mm
package_Z_c	[92 92 ; 70 70; 80 80; 100 100]	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	0.594	Fb
f_f	0.594	Fb
f_n	0.594	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	80	UI span for floating taps
bmaxg	0.2	max DFE value for floating taps
MLSE	0	logical

Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V

Thank you

Questions and Discussions