

200 Gbps/lane AUI C2M Channel Selection Criteria Update – Sept 2023

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Introduction

- This is an update to “200 Gbps/lane AUI C2M Channel Selection Criteria” from July 2023
 - https://www.ieee802.org/3/dj/public/23_07/lusted_3dj_05a_2307.pdf
- Includes revised and new channel contributions for AUI C2M
 - See P802.3dj Task Force Tools and Channel Website (<https://www.ieee802.org/3/df/public/tools/index.html>)

Goals

- The goals of this contribution are to:
 - Provide a relative comparison using COM with a reduced channel set
 - Continue discussions in the Task Force on which contributed AUI C2M channels should pass versus which should fail
 - Discuss the ones that fall in the middle
- Provide results from COM 4.1 and the two package approaches (Class A and Class B)
- Not debating the C2M specification parameters at this time, including the reference receiver model, package parameters and COM, etc.
 - Please look for the high-level trends, not at the minutiae

Reference EQ & Params Highlights – By Class

- Class I/II/III

Parameter	802.3ck C2M	802.3ck CR	802.3ck KR	802.3ck C2M-like	802.3ck CR-like	802.3ck CR-like + MLSE
DER_0	1E-5	1E-4	1E-4	1.33E-5/2E-5/2.67E-5	1.33E-5/2E-5/2.67E-5	1.33E-5/2E-5/2.67E-5
SNR_TX	32.5	32.5	33	32.5	33	33
R_LM	0.95	0.95	0.95	0.95	0.95	0.95
TxFIR Length	4 (2 pre)	5 (3 pre)	5 (3 pre)	6 (4 pre)	6 (4 pre)	6 (4 pre)
eta_0	4.10E-08	9E-09	8.2E-09	1.25E-08	1.25E-08	1.25E-08
N_b	4	12	12	1	1	1
ffe_pre_tap_len	-	-	-	4	4	4
ffe_post_tap_len	-	-	-	24	24	24
N_bg	0	3	3	0	6	6
N_bf	-	3	3	3	3	3
N_f	-	40	40	60	60	60
MLSE	0	0	0	0	0	1
Ref TX/RX Class				I	II	III

Note: these classes are starting points,
not specific recommendations.

(Mild)

(Spicy!)

Reducing the # of Channels

- Across the inventory of AUI C2M channels available, we attempted to reduce the total number of channels down to ~10-15 unique, representative channels
 - Decrease analysis time
 - Assess the outliers
 - Eliminate obviously bad channels
- Channel parameters that we used include: Fit IL, ERL, ICR

802.3dj C2M Channel Contributions

Contribution	Channel List	Host Type
rabinovich_3df_01_2209 (3x) rabinovich_3dj_02_230116 (1x)	Rabinovich_C2M_200G_Ortho_[19, 67, 93]mil_092122_Thru.s4p Rabinovich_C2M_200G_Ortho_135mil_011723_Thru.s4p	CONV PCB
rabinovich_3df_02_2209 (3x) rabinovich_3dj_03_230116 (1x)	Rabinovich_C2M_200G_Paral_[19, 67, 93]mil_092122_Thru.s4p Rabinovich_C2M_200G_Paral_135mil_011723_Thru.s4p	CONV PCB
shanbhag_3dj_03_2305 (6x)	C2M_TP0TP1a_XpYdB_PCBHost_3p7dB_THRU	CONV PCB
	C2M_TP0TP1a_XpYdB_CabledHost_7p85dB_THRU	NCC
akinwale_3dj_02_2307 (28x)	C2M_PCB_85ohms_XpYin_20230620_v3_thru1	CONV PCB
akinwale_3dj_03_2307 (27x)	C2M_PCB_93ohms_XpYin_20230620_v3_thru1	CONV PCB
akinwale_3dj_04_2307 (28x)	C2M_PCB_100ohms_XpYin_20230620_v3_thru1	CONV PCB
lim_3dj_01_2307 (1x)	li_dj_C2M_DesignA_Rev1_THRU	CONV PCB
lim_3dj_02_2307 (1x)	li_dj_C2M_DesignB_Rev1_THRU	CONV PCB
Weaver_3dj_elec_02_230831 (16X)	C2M_A_OSFP224_Xin_host_PCB_YC_thru_TP0_....s4p	CONV PCB
Kareti_3dj_02_2309 (12x)	PCB_Host_ball_ball_Xdb_set3	CONV PCB
	Cable_Host_ball_ball_Xdb_set3	NCC

<https://www.ieee802.org/3/df/public/tools/index.html>

Relative COM Comparison with Reduced List of Channels

- Evaluated with the AUI value of $DER_0 = 1.33E-5, 2E-5, 2.67E-5$
 - For division discussions
- Two package scenarios:
 - Class A: 30mm + 8mm (~7 dB IL)
 - Class B: 30mm + 8mm (~9.5 dB IL)
- Of course, the reported COM results will change depending on the channel, Cd, Cp, host and module package trace lengths, reference receiver model architecture & settings, etc.

Motion #6

Move to adopt one DER0 value of 2.67e-5 (equivalent to measured BER of 4e-5 with precoding ON) as the total allocation for 200Gbps/lane AUIs within a PHY (BER division between C2C and C2M as well as the measurement method to be determined later)

M: Adee Ran

S: Tobey P.-R. Li

Technical (>=75%)

802.3 voters only

Result: passed by unanimous consent. 9:19 a.m.

https://www.ieee802.org/3/dj/public/23_07/motions_3cwfdfj_2307.pdf

Selected List of Channels

IL (dB)	<= 16	16 < X <= 28	> 28
COM (dB)	>= 3.5	2.5 <= X < 3.5	< 2.5

Channel	IL (dB)	Fit IL (dB)	ILD (dB)	ERL (dB)	ICN (mV)	ICR (dB)	Bump-Bump IL (PKG A)	COM (DER = 1.33E-5, PKG A)			COM (DER = 2E-5, PKG A)			COM (DER = 2.67E-5, PKG A)			Bump-Bump IL (PKG B)	COM (DER = 1.33E-5, PKG B)			COM (DER = 2E-5, PKG B)			COM (DER = 2.67E-5, PKG B)			
								I	II	III	I	II	III	I	II	III		I	II	III	I	II	III	I	II	III	
Rabinovich_C2M_200G_Ortho_19mil	12.38	13.57	0.70	15.80	1.79	28.68	18.30										20.86										
Rabinovich_C2M_200G_Ortho_135mil	13.35	14.99	0.96	13.13	3.39	22.24	19.46										22.40										
Rabinovich_C2M_200G_Ortho_93mil	14.17	14.81	0.95	12.96	2.83	24.90	20.46										23.34										
Rabinovich_C2M_200G_Ortho_67mil	14.70	14.87	0.69	15.53	2.71	27.00	20.66										23.06										
shanhag/C2M_TPOTP1a_8p4dB_PCBHost_3p7dB	8.35	8.83	0.30	17.05	2.48	36.64	14.43										17.26										
shanhag/C2M_TPOTP1a_11p7dB_CabledHost_7p8dB	11.68	12.10	0.15	14.21	1.65	25.34	18.89										21.17										
shanhag/C2M_TPOTP1a_12p1dB_PCBHost_7p3dB	12.13	12.53	0.30	17.43	1.72	37.72	19.83										22.06										
shanhag/C2M_TPOTP1a_14p6dB_PCBHost_9p8dB	14.61	14.99	0.31	17.58	1.39	37.43	21.39										24.04										
shanhag/C2M_TPOTP1a_17p1dB_PCBHost_12p2dB	17.12	17.43	0.31	17.70	1.14	37.48	24.68										27.06										
shanhag/C2M_TPOTP1a_19p6dB_PCBHost_14p6dB	19.60	19.87	0.32	17.79	0.95	37.60	26.70										29.18										
akinwale_3dj_02_2307/C2M_PCB_93ohms_1p0in	7.64	7.96	0.25	14.89	4.17	27.30	14.00										16.80										
akinwale_3dj_02_2307/C2M_PCB_93ohms_5p0in	14.43	14.47	0.23	16.38	2.83	25.31	21.72										23.89										
akinwale_3dj_02_2307/C2M_PCB_93ohms_9p0in	20.96	20.86	0.26	16.45	2.37	22.92	27.70										30.13										
akinwale_3dj_02_2307/C2M_PCB_93ohms_11p0in	24.21	24.01	0.28	16.48	2.24	21.47	31.05										33.39										
li_dj_C2M_Design_B_Rev1_THRU.s4p	11.57	11.59	0.38	15.48	2.46	27.78	17.75										20.32										
li_dj_C2M_Design_A_Rev1_THRU.s4p	11.61	11.69	0.18	14.75	4.06	24.23	18.09										20.54										
weaver/egress/C2M_X_OSFP224_3in_host_PCB_80C	7.32	7.91	0.18	14.04	5.12	27.99	13.33										16.28										
weaver/egress/C2M_X_OSFP224_5in_host_PCB_80C	10.08	10.73	0.17	14.30	4.05	28.01	16.97										19.70										
weaver/egress/C2M_X_OSFP224_7in_host_PCB_80C	12.91	13.53	0.17	14.48	3.27	27.53	20.28										22.78										
weaver/egress/C2M_X_OSFP224_9in_host_PCB_80C	15.71	16.31	0.18	14.60	2.72	26.74	23.23										25.61										
Kareti/Cabled_Host_ball_ball_11db.s4p	11.65	12.83	0.64	7.78	3.83	24.86	17.77										20.36										
Kareti/Cabled_Host_ball_ball_14p5db.s4p	15.28	16.40	0.64	8.25	3.05	24.21	21.80										24.30										
Kareti/Cabled_Host_ball_ball_20p5db.s4p	21.18	22.37	0.64	8.65	1.89	23.58	28.44										30.83										
Kareti/Cabled_Host_ball_ball_22p6db.s4p	23.22	24.37	0.65	8.65	1.63	23.54	30.47										32.82										
Kareti/Cabled_Host_ball_ball_24p5db.s4p	25.19	26.31	0.66	8.66	1.48	23.04	32.18										34.65										
Kareti/Cabled_Host_ball_ball_26p4db.s4p	27.12	28.43	0.66	8.77	1.33	22.70	34.14										36.53										

Contribution	Contribution
akinwale_3dj_02_2307 (28x)	shanhag_3dj_03_2305 (6x)
akinwale_3dj_03_2307 (4x, [1 5 9 11] in)	lim_3dj_01_2307 (1x) lim_3dj_02_2307 (1x)
akinwale_3dj_04_2307 (28x)	Weaver_3dj_elec_02_230831 (4x, egress, conn X, 80C)
rabinovich_3df_01_2209 (3x) rabinovich_3dj_02_230116 (1x)	Kareti_3dj_02_2309 (6x, cable host)
rabinovich_3df_02_2209 (3x) rabinovich_3dj_03_230116 (1x)	

Summary

- Provided an update of results with COM 4.1 for the new or revised 200G/lane AUI C2M channels
 - Two example values of DER_0: 2.67E-5, 2E-5, 1.33E-5
 - Two package approaches (Class A and Class B)
- Next steps:
 - Agree on which 200G/lane AUI C2M channels are to “pass” vs. “fail”
 - Where do we draw the line?
 - Perform more analysis (as required) when:
 - Reference EQ parameters/values change
 - AUI C2C vs. C2M BER division solidifies

Thanks!

BACKUP

COM Reference Sheets for Class I/II/III, PKG A

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	2		[test cases to run]
z_p (TX)	[15 30; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[8 8; 0 0]	mm	[test cases]
z_p (FEXT)	[15 30; 1.8 1.8]	mm	[test cases]
z_p (RX)	[8 8; 0 0]	mm	[test cases]
PKG_Tx_FFE_preset	0		
C_p	[0.4e-4 0.4e-4]	nF	[TX RX]
R_o	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)	[0:0.02:0.2]		[min:step:max]
c(-3)	[-0.04:0.02:0]		[min:step:max]
c(-4)	[0:0.02:0.02]		[min:step:max]
c(1)	[-0.12:0.02:0.04]		[min:step:max]
N_b	1	UI	
b_max(1)	0.75		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
sample_adjustment	[0 0]	phase	
ts_anchor	0		

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	2.00E-05		
T_r	4.00E-03	ns	
FORCE_TR	1	logical	
PMD_type	C2C		
EW	1		
* TDR and ERL options			
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			
sigma_RJ	0.01	UI	
A_DD	0.02	UI	
eta_0	1.25E-08	V^2/GHz	
SNR_TX	33	dB	
R_LM	0.95		
Enforce Causality	1		
S-parameter magnitude extrapolation policy	trend_to_DC		
Filter: RxFFE			
ffe_pre_tap_len	4	UI	
ffe_post_tap_len	24	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		

Parameter	Setting	Units
package_tl_gamma0_a1_a2	[5e-4 8.9e-4 2e-4]	
package_tl_tau	0.006141	ns/mm
package_Z_c	[87.5 87.5; 92.5 92.5]	Ohm
Parameter		
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_o	[0.2e-4 0]	nF
C_1	[0.2e-4 0]	nF
Include PCB	0	logical
Selections (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	60	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

* ERL and ICN parameters

** Make changes of Class I/II/III based on parameters listed in slide 5

COM Reference Sheets for Class I/II/III, PKG B

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	2		[test cases to run]
z_p (TX)	[15 30 45; 1 1 1 ; 1 1 1 ; 0.5 0.5 0.5]	mm	[test cases]
z_p (NEXT)	[8 8 8; 0 0 0 ; 0 0 0 ; 0 0 0]	mm	[test cases]
z_p (FEXT)	[15 30 45; 1 1 1 ; 1 1 1 ; 0.5 0.5 0.5]	mm	[test cases]
z_p (RX)	[8 8 8; 0 0 0 ; 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_o	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)	[0:0.02:0.2]		[min:step:max]
c(-3)	[-0.04:0.2:0]		[min:step:max]
c(-4)	[0:0.02:0.2]		[min:step:max]
c(1)	[-0.12:0.02:0.04]		[min:step:max]
N_b	1	UI	
b_max(1)	0.75		As/dfe1
b_max(2..N_b)	[0.3 0.2*ones(1,22)]		As/dfe2..N_b
b_min(1)	0		As/dfe1
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
sample_adjustment	[0 0]	phase	
ts_anchor	0		

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			
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			
sigma_RJ	0.01	UI	
A_DD	0.02	UI	
eta_0	1.25E-08	V^2/GHz	
SNR_TX	33	dB	
R_LM	0.95		
Enforce Causality	1		
S-parameter magnitude extrapolation policy	trend_to_DC		
Filter: RxFFE			
ffe_pre_tap_len	4	UI	
ffe_post_tap_len	24	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 8.455e-4 3.40225e-4]	
package_tl_tau	0.00644805	ns/mm
package_Z_c	[92 92; 70 70; 80 80; 100 100]	Ohm
Parameter	Setting	Units
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	60	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

*ERL and ICN parameters

** Make changes of Class I/II/III based on parameters listed in slide 5