Practical C2M Loss Limit

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IEEE 802.3dJ Plenary Meeting
Montreal

July 15, 2024

Overview

- COM settings and configurations
- Highlights of Kareti and Weaver channels
- COM results by adding PCB trace
- Module plug losses
- C2M limits
- Summary.

COM Key Settings

- **Analysis is preliminary based on recently released COM 4.6Beta4**
  - All results with MMSE local search taking ~5 min each by constraining CTLE and TX FFE tap ranges
- **Key COM parameters**
  - TX FFE configuration: 2 pre taps with one post, for configuration investigated pre/post taps were all 0
  - ASIC 45 mm Package B (high loss)
  - CDR package 8 mm
- **COM equalizer as adopted in lusted_3dj_01a_2406 (items in blue below indicates parameters adopted by lusted contribution)**
  - Eta0=1.0E-8
  - A_v=A_fe=0.413, A-ne=0.45
  - RX FFE 6 pre-cursors, 8 post cursors, 2 banks of 4T floating with 50 UI span
  - COM limit 3 dB
  - DER0=2E-5
  - gDC≤5 dB with g_DC_HP≤5 dB, total CTLE gain was ~ 6 dB
  - DFE max tap =0.75 (did not reach max for any of the cases).

COM Config File

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]
R_d	[46.25 46.25]	Ohm	[TX RX]
R_0	50	Ohm	
PKG_NAME	PKG_HiR_CLASSB PKG_Module		TX RX
A_v	0.413	V	rqd syntx
A_fe	0.413	V	rqd syntx
A_ne	0.45	V	rqd syntx
L	4		
M	32		
filter and Eq			
f_r	0.565	*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		[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	[-5:1:0]	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

I/O control		
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 TP1a_COM_model	
COM_CONTRIBUTION	1	logical
Operational		
ERL Pass threshold	10	dB
COM Pass threshold	3	db
VEC Pass threshold	10.69073041	
DER_0	2.00E-05	
T_r	4.00E-03	ns
FORCE_TR	1	logical
Min_VEO_Test	0	mV
PMD_type	C2M	
T_O	50	mUI
samples_for_C2M	100	samples/UI
EW	0	
MLSE	0	
ts_anchor	1	
sample_adjustment	[-12 12]	
LocalSearch	2	
FFE_OPT_METHOD	MMSE	FV-LMS or MMSE
num_ui_RXFF_noise	1024	

Noise, jitter		
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	

Table 93A–3 parameters			
Parameter	Setting	Units	Information
package_tl_gamma0_a1_a2	[5e-4 0.00065 0.0003]		rqd syntx
package_tl_tau	0.006141	ns/mm	rqd syntx
package_Z_c	[92 92 ; 70 70; 80 80; 100 100]	Ohm	rqd syntx
z_p select	[4]		rqd syntx
z_p (TX)	[8 24 30 45 ; 1 1 1 1; 1 1 1 1 ; 0.5 0.5 0.5 0.5]	mm	rqd syntx
z_p (NEXT)	[8 8 8 8; 0 0 0 0 ;0 0 0 0 ; 0 0 0 0]	mm	rqd syntx
z_p (FEXT)	[8 24 30 45 ; 1 1 1 1; 1 1 1 1 ; 0.5 0.5 0.5 0.5]	mm	rqd syntx
z_p (RX)	[8 8 8 8; 0 0 0 0 ;0 0 0 0 ; 0 0 0 0]	mm	rqd syntx
C_p	[0.4e-4 0.4e-4]	nF	rqd syntx
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	0.2	max DFE value for floating taps	
B_float_RSS_MAX	0.1	rss tail tap limit	
N_tail_start	9	(UI) start of tail taps limit	
Filter: Rx FFE			
ffe_pre_tap_len	5	UI	
ffe_post_tap_len	8	UI	
ffe_pre_tap1_max	0.7	(normalized)	
ffe_post_tap1_max	0.7	(normalized)	
ffe_tapn_max	0.7	(normalized)	
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	UI	
N_bx	20		
fixture delay time	[0 0]		
Tukey_Window	1		

SAVE_CONFIG2MAT	0	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
ICN parameters		
f_v	0.588	Fb
f_f	0.278	Fb
f_n	0.278	Fb
f_2	60.031	GHz
A_ft	0.450	V
A_nt	0.450	V

Parameter	**Setting**	
board_tl_gamma0_a1_a2	*[0 6.44084e-4 3.6036e-05]*	1.4 db/in @ 53.125G
board_tl_tau	*5.790E-03*	ns/mm
board_Z_c	95	Ohm
z_bp (TX)	*100*	mm
z_bp (NEXT)	*100*	mm
z_bp (FEXT)	*100*	mm
z_bp (RX)	*0*	mm
C_0	[0 0]	nF
C_1	[0 0]	nF
Include PCB	**0**	**logical**
Seletions (rectangle, gaussian, dual_rayleigh, triangle		
Histogram_Window_Weight	gaussian	selection
Qr	*0.02*	UI

baseline	
new	
relevant for RxFFE	
adjusted in experiment	

59.03
59.03
106.25

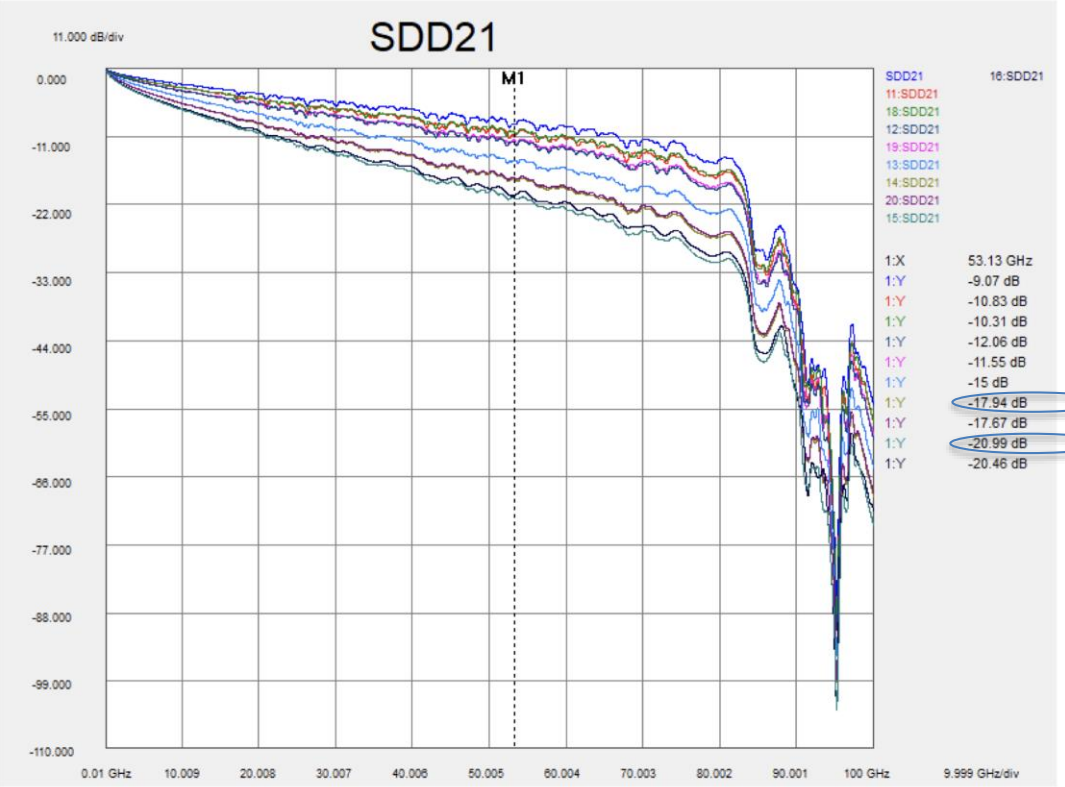
.START	PKG_LowR_CLASSA	[2.4 4 5.7] db	
Table 93A–3 parameters			
Parameter	Setting	Units	Information
ckage_tl_gamma0_a1_	[0.0005 0.00089 0.0002]		
package_tl_tau	0.006141	ns/mm	
package_Z_c	[87.5 87.5 ; 92.5 92.5 ; 100 100; 100 100]	Ohm	
R_d	[46.25 46.25]	Ohm	[TX RX]
z_p (TX)	[12 24 30 45 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
z_p (NEXT)	[12 24 30 45 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
z_p (FEXT)	[12 24 30 45 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
z_p (RX)	[12 24 30 45 ; 1.8 1.8 1.8 1.8 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
C_p	[0.4e-4 0.4e-4]	nF	[TX RX]
A_v	0.413	V	Vf=0.400
A_fe	0.413	V	Vf=0.399
A_ne	0.45	V	Vf=0.400
.END			

.START	PKG_HiR_CLASSB	[2.8 5.6 6.7 9.4] db	
Table 93A–3 parameters			
Parameter	Setting	Units	Information
ckage_tl_gamma0_a1_	[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	
R_d	[46.25 46.25]	Ohm	[TX RX]
z_p (TX)	[12 24 30 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm	[test cases]
z_p (NEXT)	[12 24 30 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm	[test cases]
z_p (FEXT)	[12 24 30 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm	[test cases]
z_p (RX)	[12 24 30 45 ; 2 2 2 2; 1.3 1.3 1.3 1.3 ; 1.5 1.5 1.5 1.5]	mm	[test cases]
C_p	[0.4e-4 0.4e-4]	nF	[TX RX]
A_v	0.413	V	Vf=0.400
A_fe	0.413	V	Vf=0.399
A_ne	0.45	V	Vf=0.400
.END			

.START	PKG_Module		
Table 93A–3 parameters			
Parameter	Setting	Units	Information
ckage_tl_gamma0_a1_	[0.0005 0.00089 0.0002]		
package_tl_tau	0.006141	ns/mm	
package_Z_c	[87.5 87.5 ; 95 95 ; 100 100; 100 100]	Ohm	
R_d	[46.25 46.25]	Ohm	[TX RX]
z_p (TX)	[8 8 8 8 ; 0 0 0 0 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
z_p (NEXT)	[8 8 8 8 ; 0 0 0 0 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
z_p (FEXT)	[8 8 8 8 ; 0 0 0 0 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
z_p (RX)	[8 8 8 8 ; 0 0 0 0 ; 0 0 0 0 ; 0 0 0 0]	mm	[test cases]
C_p	[0.4e-4 0.4e-4]	nF	[TX RX]
A_v	[0.4057 0.4057 0.4057 0.4057]	V	Vf=0.400
A_fe	[0.4057 0.4057 0.4057 0.4057]	V	Vf=0.399
A_ne	[0.45 0.45 0.45 0.45]	V	Vf=0.400
.END			

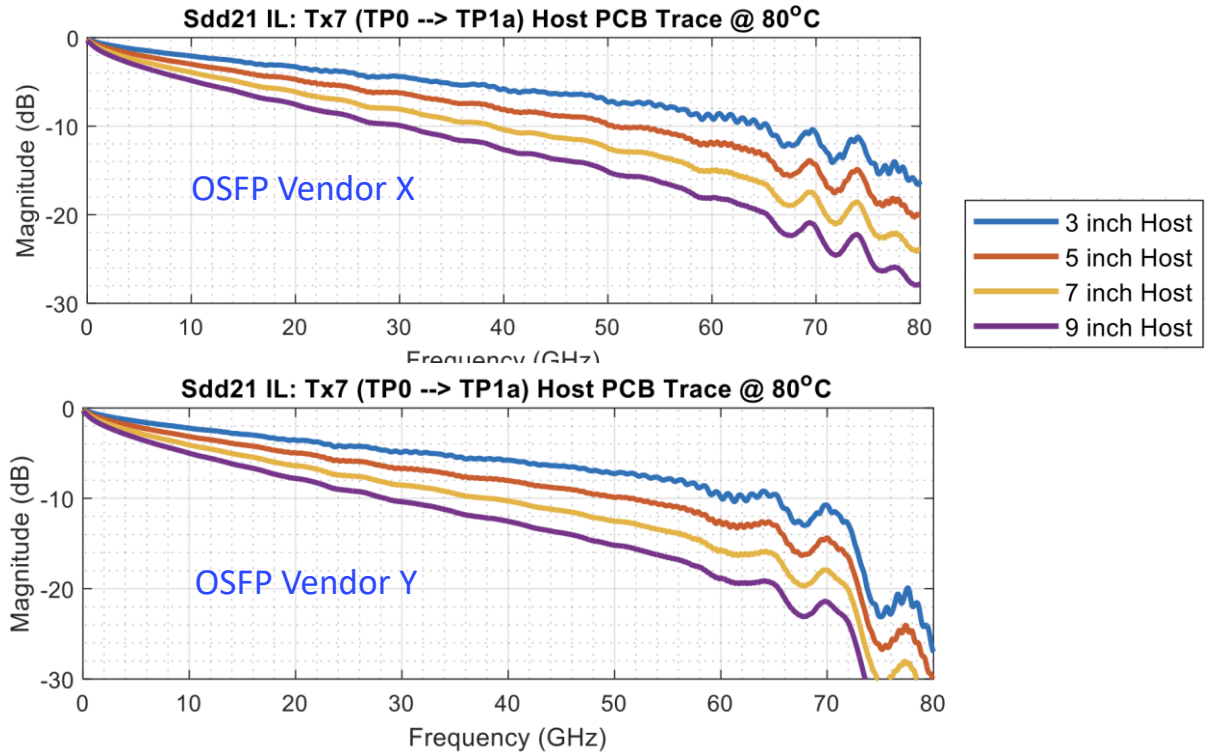
Channels for This Study

- **Kareti SL. No 8 and 10 channels higher loss used for the study**
- **Weaver 9” OSFP channels vendor X and Y used for the study**



SL. No 8

SL. No 10



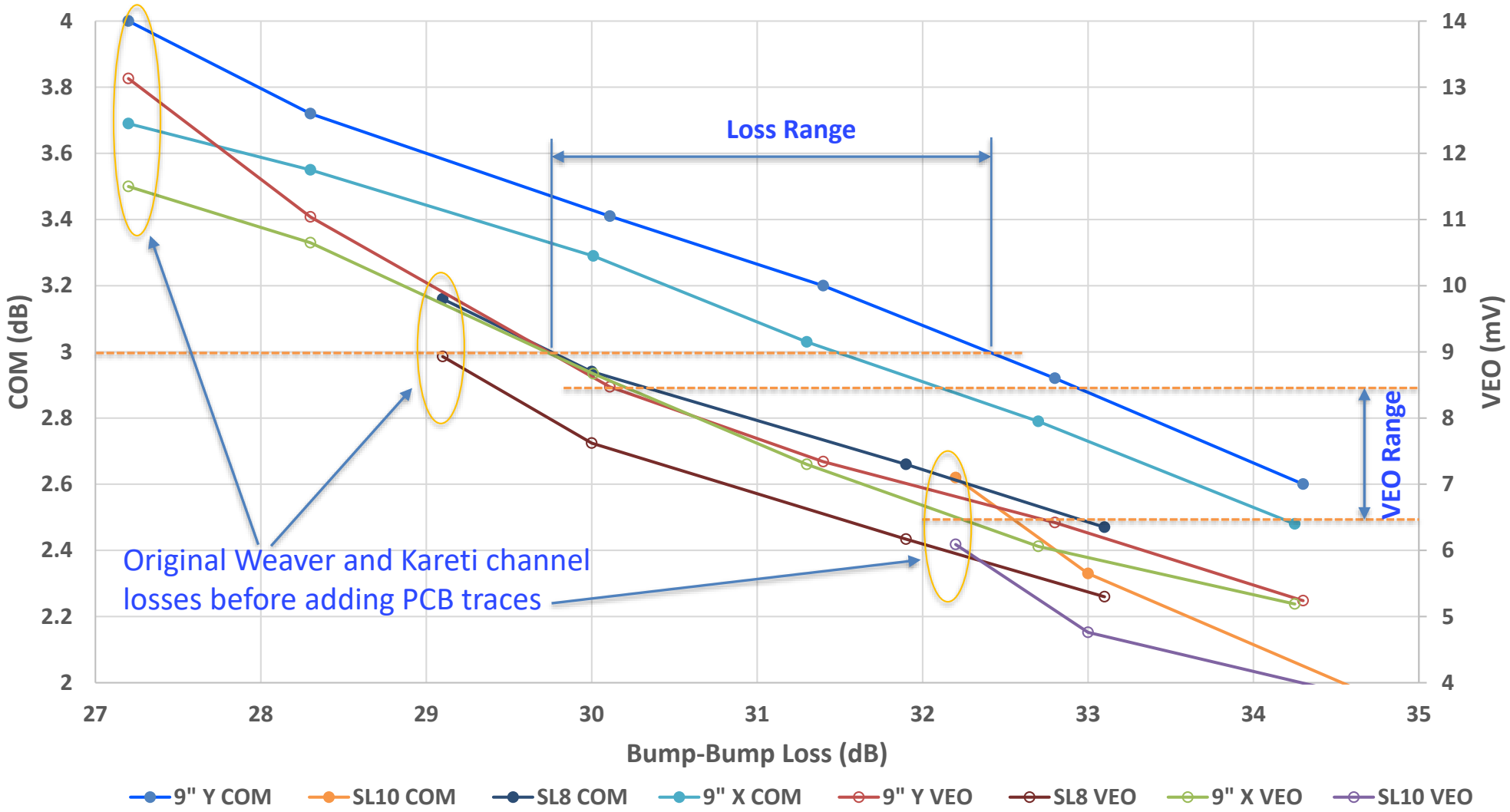
Highlighted Channel Parameters for This Study

- **Key difference between Kareti and Weaver channels are:**
  - FOM ILD is much higher on Kareti channels
  - ICN is much higher on the Weaver OSFP vendor X channel.

Channel	Trace Length (in)	Channel IL (dB)	ICN (mV)	FOM ILD	ERL11	ERL22	IL b-b with PKG B 30 mm+8mm CDR (dB)	IL b-b with PKG B 45 mm+8mm CDR (dB)
Kareti SL No 8	Unknown	17.9	1.37	0.147	16.8	15.9	26.4	29.1
Kareti SL No 10	Unknown	21.2	1.12	0.147	17.2	16.1	29.5	32.2
Weaver Vendor "X" OSFP Tx7	9	15.7	1.83	0.080	21.5	15.3	24.5	27.1
Weaver Vendor "Y" OSFP Tx7	9	16.1	1.03	0.074	21.8	15.8	24.6	27.2

COM and VEO as Function of Loss

- **On Weaver 9” vendor Y OSFP (lower ICN) 32.5 dB loss can be support but on Kareti channel only ~30 dB can be supported!**



Module Plug Losses

- **Most module use 1 mm PCB except OSFP-XD that uses 1.2 mm plug PCB**
  - Typical module plug PCB/mSAP trace lengths expect to be < 20 mm
  - Adopted **3.8 dB** HCB loss is sufficient to for both conventional plug with 10 mm package trace and mSAP implementation, see ghiasi_3dj_02_2401 .

Module Trace Ranges	Loss (Class A) (dB/mm)	Loss (dB)	DC Block Loss (dB)	Total Loss (dB)
15 mm	0.15	2.25	0.5	2.8
20 mm	0.15	3.0	0.5	3.6
22.5 mm	0.15	3.4	0.5	3.9

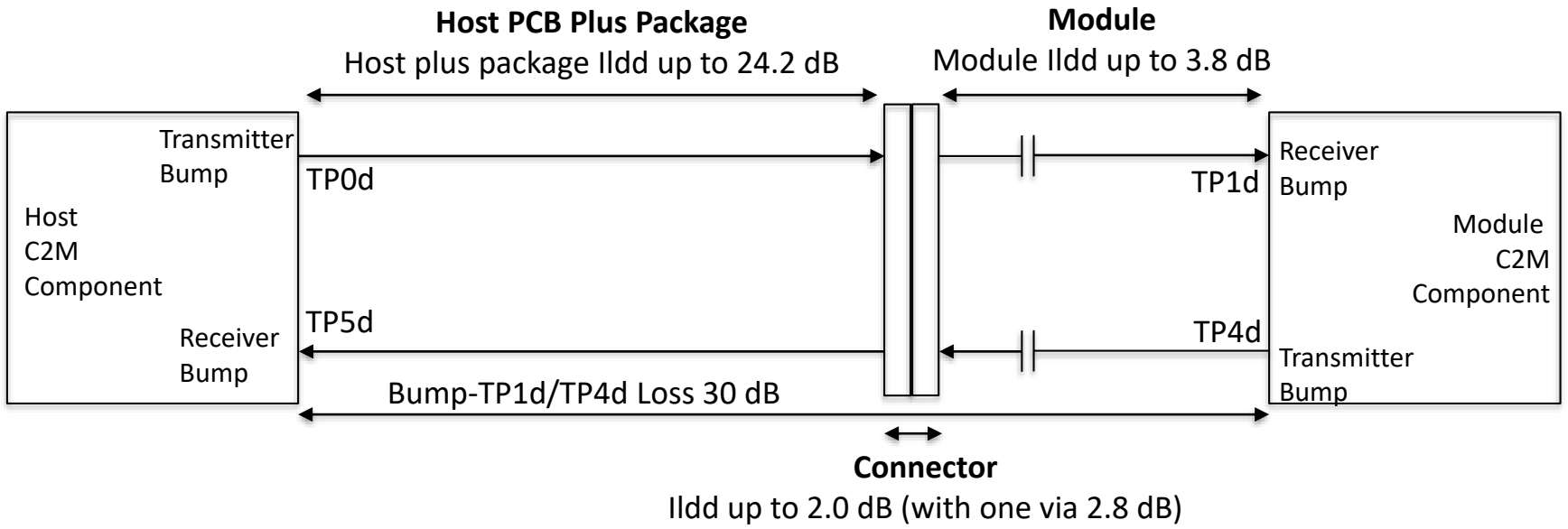
mSAP Construction

Module Trace Ranges	PC Loss (dB/in)	Loss (dB)	DC Block Loss (dB)	Loss (Class B) (dB/mm)	CDR PKG Trace (mm)	CDR PKG Loss (dB)	Total Loss (dB)
15 mm	1.5	0.9	0.5	0.195	10	1.95	3.35
20 mm	1.5	1.2	0.5	0.195	10	1.95	3.65
25.4 mm	1.5	1.5	0.5	0.195	10	1.95	3.95

Conventional Construction

C2M Application Reference Model

- **The task force shouldn't specify C2M loss where only the best of the best channels will pass COM**
  - Based on the above criteria 30 will be a safe C2M target loss
  - Allow host plus package Ildd up to 24.2 dB
- **Limits at TP1d and TP5d far-end**
  - COM=3 dB/VEC=10.7 dB and VEO=8 mV.



Summary

- **COM analysis with version 4.6Beta4 with adopted C2M reference equalizer with 5 pre-cursors, 8 post-cursors, and 2 banks of floating taps with a span of 50 UI**
  - Results are comparable to ghiasi_3dj_02a_2405 contribution with fixed 25 tap equalizer on Kareti and Weaver high loss channels
- **Current 3.8 dB HCB loss is sufficient to support both conventional plug PCB with 10 mm package and mSAP implementation without a package**
  - Analysis here included 8 mm core-less package
- **Weaver OSFP vendor Y OSFP (ILD=0.074 and ICB=1.03 mV) with addition of 125 mm PCB trace has a loss of 32.5 dB and passes 3 dB COM**
  - But at 32.5 dB Weaver vendor X OSFP and Kareti channels will fail 3 dB COM
- **The expectation of C2M target loss is a high confidence limit of at least 95% success then bump-bump loss of 30 dB is the right value, but > 32 dB is possible with extra care**
- **Proposed limits based on 30 dB loss**
  - COM=3 dB/VEC=10.7 dB
  - VEO=8 mV.