COM Study for 15-20 dB Channels of CAUI-4 Chip-to-Chip Link

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Purposes

- Explore the solution space and technical feasibility for CAUI-4 chip-to-chip (C2C) 15-20 dB channels using 802.3bj COM (a channel compliance simulator) under the assumptions of
  - Tx FIR + Rx CTLE equalizations
  - No FEC
  - BER at 1e-15
  - A measured 15dB, and 20 dB (IL) channel with xtalk and ILD

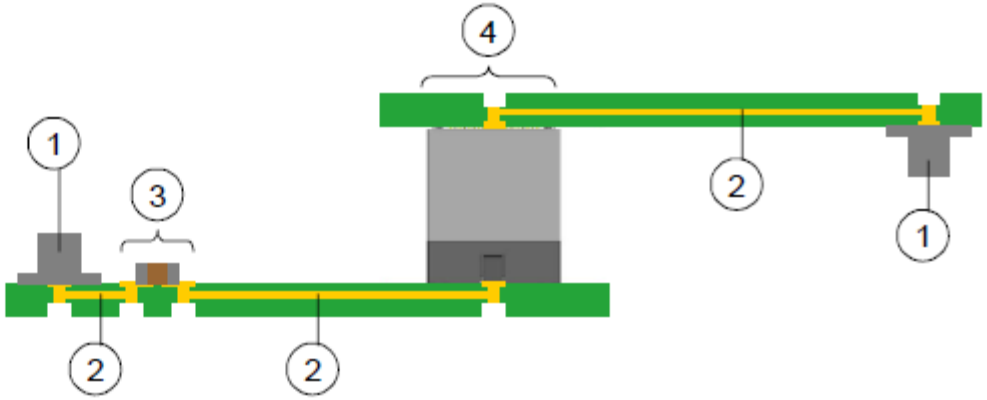
Background and Motivation

- Study 1 based on a 20 dB ([1]) synthesized channel with IL and xtalk was presented in Jan meeting.
- Study 2 based on a 13 dB and a 15 dB ([2]) measured channels with IL, ILD, and xtalk were presented in March meeting.
- Study 3 based on a 20 dB ([3]) measured channel with IL, ILD, and xtalk were presented in May meeting.
- [1],[2],[3] have shown the technical feasibility and solution margin for 15-20 dB IL channels for CAUI4 c2c, using the Altera HSIO link simulator.
- This study (study 4) focuses on 15-20 dB measured channels, with ILD, and xtalk, using the 802.3bj COM, 2.1_v02

I. Channel Consideration

A 20 dB C2C Channel Topology

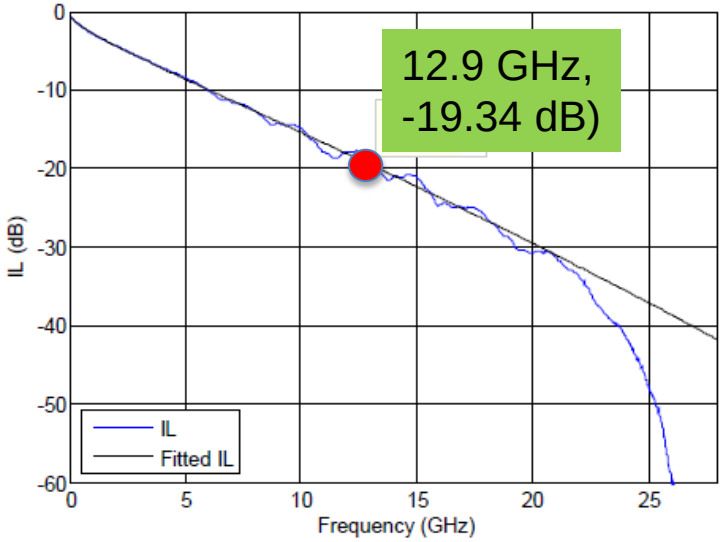
1. SMA connector
2. Stripline trace
3. DC blocking capacitor
4. IT5 connector

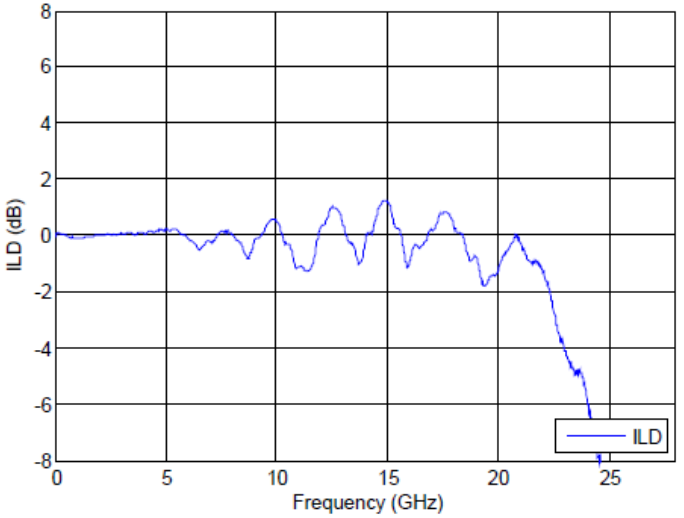


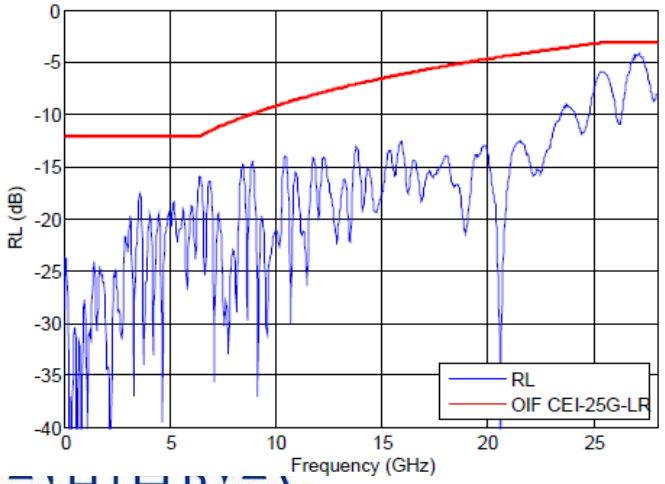
- Provided by Hirose

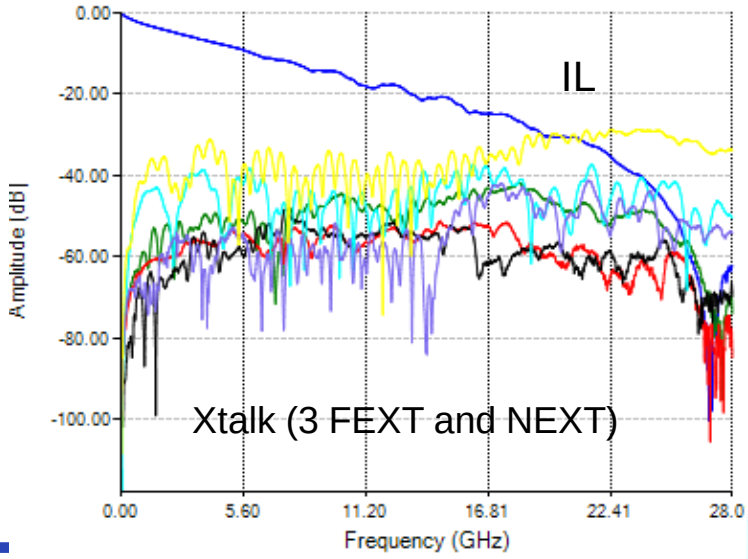
20 dB C2C Channel Characteristics (I)

- IL, ILD, RL, xtalk (provided by Hirose)

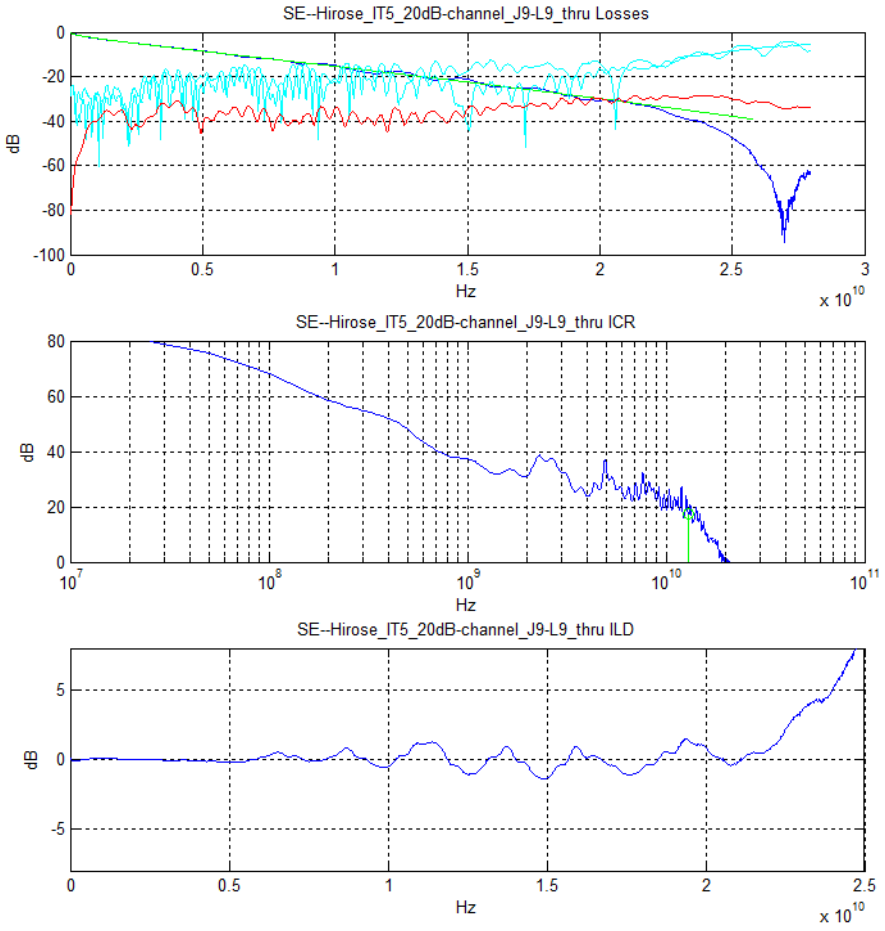








20 dB C2C Channel Characteristics (II)



IL, IL_fit, RL, Xtalk

ICR

ILD

- Obtained from running COM (http://www.ieee802.org/3/bj/public/tools/mellitz_3bj_com_d2p1_02_0613.zip)

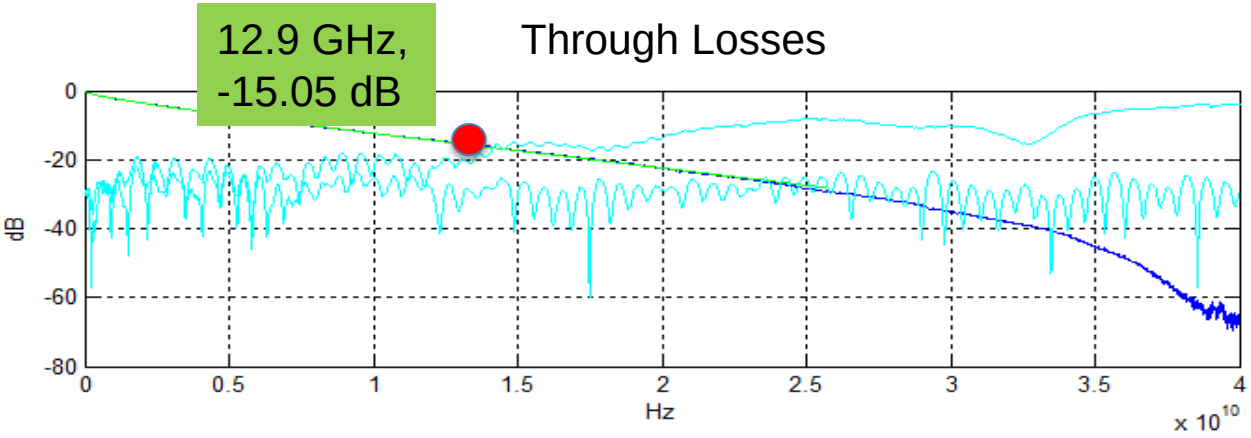
20 dB C2C Channel Characteristics (III)

Parameter	Value
Peak_MDXTK_interference (mv)	25.780000
Peak_MDNEXT_interference (mv)	24.760000
Peak_MDFEXT_interference (mv)	2.680000
ICN (mv, rms)	7.041063
ILD (mv, rms)	0.396556
ILD_peak (dB, at <=Nyquist)	+-1.17
ICR (dB, at Nyquist)	17.14

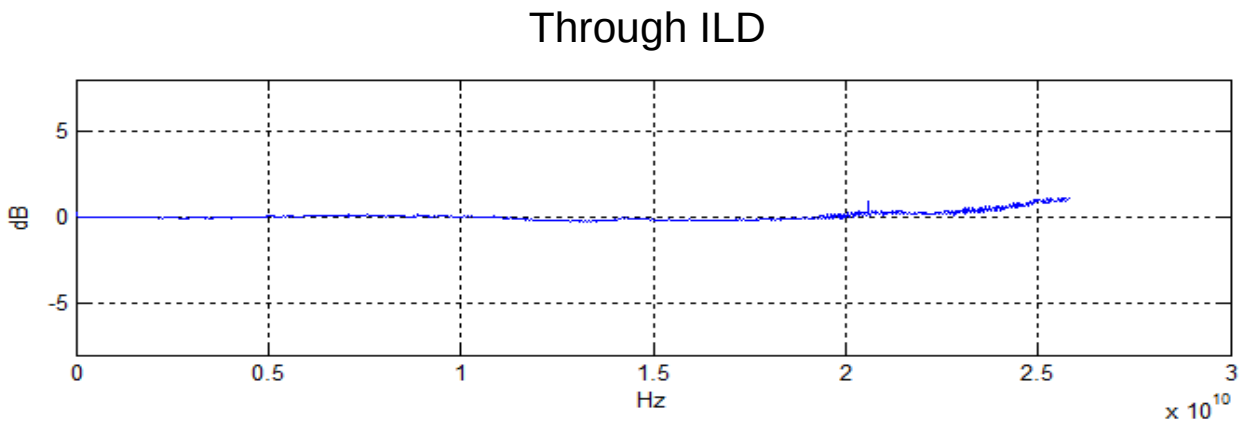
- From running COM

15 dB C2C Channel Characteristics (I)

- IL, ILD, RL (Channel S-parameter provided Ali Ghiasi)
- No xtalk



IL, IL_fit, RL



ILD

15 dB C2C Channel Characteristics (II)

Parameter	Value
Peak_MDXTK_interference (mv)	0
Peak_MDNEXT_interference (mv)	0
Peak_MDFEXT_interference (mv)	0
ICN (mv, rms)	0
ILD (mv, rms)	0.080058
ILD_peak (dB, at <=Nyquist)	+-0.26
ICR (dB, at Nyquist)	-

- From running COM

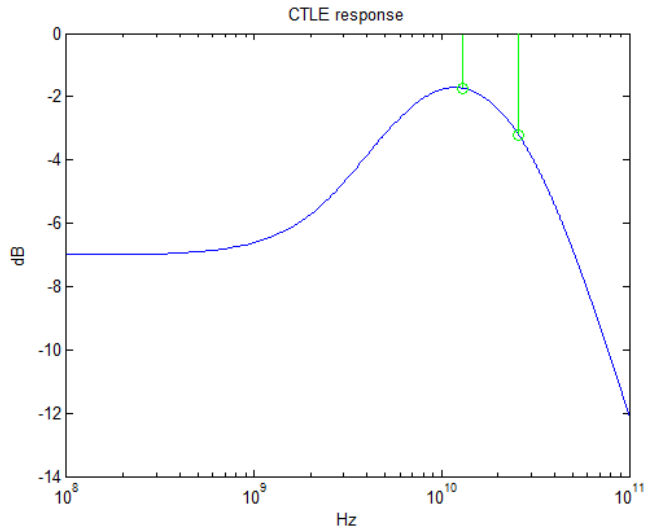
II. COM Setup and Results

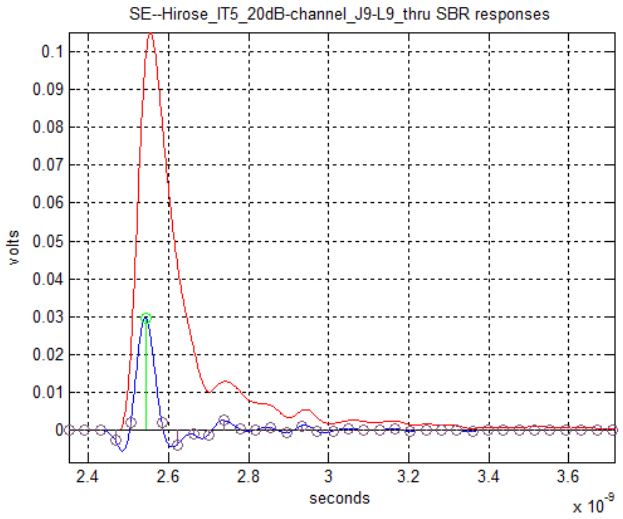
COM Default Setup for the 20 dB Channel

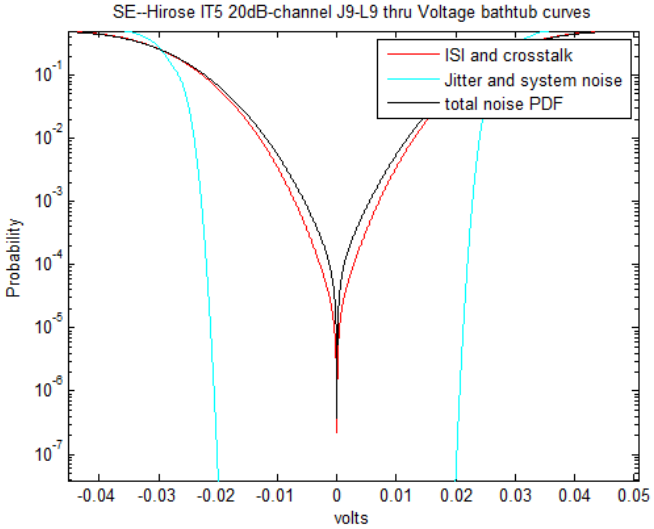
Parameter	Setting	
Coding/Port Type	CAUI-4	
Signal Rate (fb)	25.78125	GHz
[c(-1) c(1)]	[-.18 -.38]	
Nb	0	UI
Gdc, for CTF	-16	dB
Av	0.4	V
Af	0.4	V
An	0.6	V
L	2	
DER0	1.00E-05	
CC1	3	Min COM dB
sigma_rj	0.01	UI
Add	0.07	UI
sigma_r	5.00E-04	V
eta_0	6.40E-08	V^2/GHz
PDF_bin_size	1.00E-05	V
Samples Per UI	32	

Parameter	Setting	
Port Order	[1 3 2 4]	
CTF_step	1	dB
TXFFE_step	0.02	
bmax(1)	1	
bmax(2..Nb)	1	
f_r	0.75	*fb
package_tl_gamma	complex([-0.0010037 -0.0003539 -0.001027 0 -1.178e-05], [0 -0.003355 -0.03818 0 3.363e-05])	
package_tl_rho	complex([0.0011007 3.679e-18 -0.0003235 -1.021e-20 1.722e-07], [0 -0.008124 -3.545e-20 7.44e-06 -1.8e-21])	
C_d	2.50E-04	nF
R_d	55	Ohm
C_p	1.80E-04	nF
z_p	12	mm
WGN_step	0.0005	v rms

Results from COM for Default Setting with 20 dB Channel







COM = **-4.572657**

Channel fails.

20 dB Channel Solution Space Search with COM

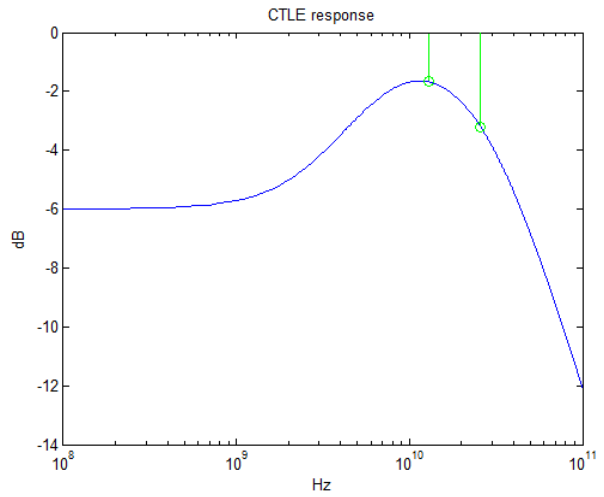
Setup	Default	BER drop to 1e-5	No xtalk	No (xtalk+ jitter)	No (xtalk +jitter +noise)	Add 20 Tap DFE
COM	**-4.573**	**-1.099**	**-0.841**	**0.804**	**0.804**	**0.96**
Setup	pkg L drops to half	Cpad drops to half	Cpin drops to half	Cpad, Cpin, L all drop to half	Cpad, Cpin, L all drop to zero	Add 20 Tap DFE, with ideal pkg
COM	**-4.592**	**-3.614**	**-3.773**	**-2.524**	**-1.23**	**2.636**

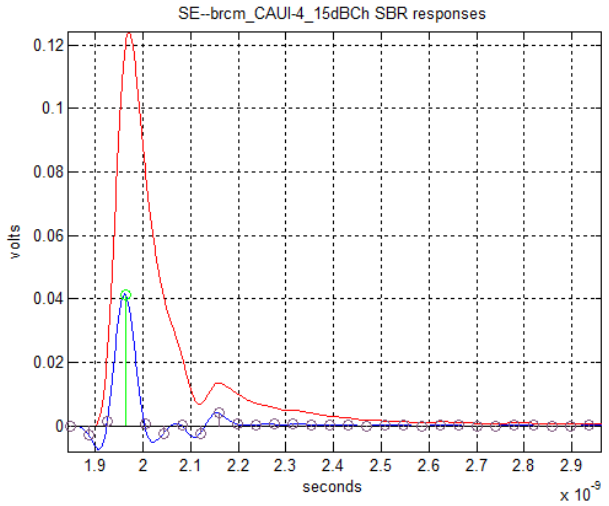
COM Default Setup for the 15 dB Channel (No xtalk)

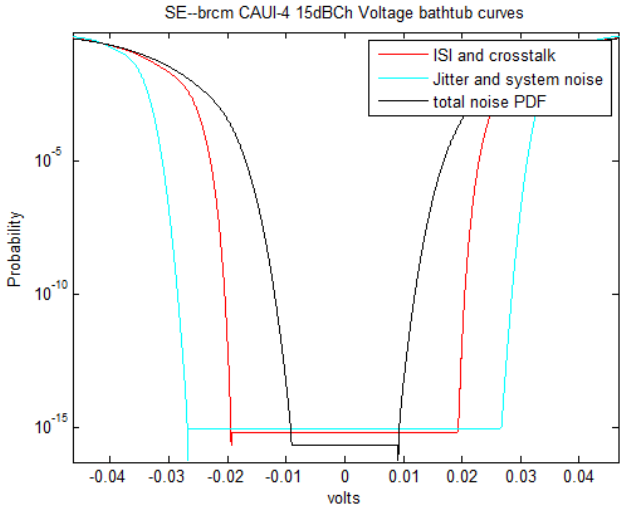
Parameter	Setting
Coding/Port Type	CAUI-4
Signal Rate (fb)	25.78125
[c(-1) c(1)]	[-.18 -.38]
Nb	0
Gdc, for CTF	-16
Av	0.4
Af	**0**
An	**0**
L	2
DER0	1.00E-15
CC1	3
sigma_rj	0.01
Add	0.07
sigma_r	5.00E-04
eta_0	6.40E-08
PDF_bin_size	1.00E-05
Samples Per UI	32

Parameter	Setting	
Port Order	[1 3 2 4]	
CTF_step	1	dB
TXFFE_step	0.02	
bmax(1)	1	
bmax(2..Nb)	1	
f_r	0.75	*fb
package_tl_gamma	complex([-0.0010037 -0.0003539 -0.001027 0 -1.178e-05], [0 -0.003355 -0.03818 0 3.363e-05])	
package_tl_rho	complex([0.0011007 3.679e-18 -0.0003235 -1.021e-20 1.722e-07], [0 -0.008124 -3.545e-20 7.44e-06 -1.8e-21])	
C_d	2.50E-04	nF
R_d	55	Ohm
C_p	1.80E-04	nF
z_p	12	mm
WGN_step	0.0005	v rms

Results from COM for Default Setting with 15 dB Channel (No xtalk)







COM = **2.151394**

Channel fails

III. Summary and Closing Remarks

Summary (I)

- A channel study with COM for CAUI-4 C2C at 25.78 Gbps is carried out, for a 20 dB and a 15 dB measured channel.
- No solution can be found to meet 3 dB COM threshold with the COM default setting for CAUI-4 for both 20 dB and 15 dB channels studied.
- Further solution space searches (focused on improved transceiver/package and channel conditions/capabilities) have been carried for the 20 dB channel, and yet no solution can be identified. Search conditions include:
  - No xtalk from channel
  - No jitter&noise from transceiver & no xtalk from channel
  - Ideal package
  - Turned on a 20 tap DFE with ideal or default package (802.3 bj)

Summary (II)

- If COM would be used for the CAUI-4 C2C channel compliance and enables the 20 dB objective, new/modified COM specification and COM code would be required for CAUI-4 C2C. Potential changes/improvements may include, but not limited to:
  - Improved package assumption/model
  - Improved CTLE (e.g., active, with sufficient AC/DC gains, vs passive CTLE now used)
  - Moderate jitter to noise conversion vs conservative
  - Etc….
- An alternative channel compliance method for CAUI-4 could be based on channel impairment limits (IL, IL_fit, ILD, ICN), such as that of CEI-28G-MR.

References

[1]: http://www.ieee802.org/3/bm/public/jan13/li_01_0113_optx.pdf

[2]: http://www.ieee802.org/3/bm/public/mar13/li_01_0313_optx.pdf

[3]:http://www.ieee802.org/3/bm/public/may13/li_01a_0513_optx.pdf

Acknowledgements

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