

# **A CAUI-4 Specification Method Supporting 15-20 dB Chip-to-Chip Channels**

Mike Peng Li  
Altera Corporation  
Rev1.3

For IEEE 802.3bm

Sept 4th, 2013

# Supporters

- Elizabeth Kochuparambil, Cisco
- Rick Rabinovich, ALU

# Purposes

- Propose a self-contained and complete spec/parameters for CAUI4 c2c RX interference tolerance and channel in supporting 15-20 dB channels

# Proposed RX Interference Tolerance Test: Option (I)

Table 83D-3 Receiver interference tolerance test parameters

Parameter	Test Value	Unit
Max BER	1e-15	
Applied peak-to-peak sinusoidal jitter	5 UI at 0.1 MHz, 0.05 UI at 10 MHz	UI
Applied broad-band noise	Adjusted to meet the EH and EW	mv (rms)
Applied random jitter	Adjusted to meet the EH and EW	ps (rms)
Min Eye-Height (EH) after ref RX	30	mv
Min COM after ref RX	2	
Channel Insertion loss at 12.89 GHz	15, 20	dB

## Proposed Reference Receiver Definition: Option (I) cont..

- Reference RX is composed of behavior models of
  - Rx package
  - CTLE/DFE
- For up to 15, 20 dB channels, CTLE + 4-tap DFE is enabled for ref RX
- Reference RX is defined and provided by the updated COM

## Updated Behavioral CTLE Definition: Option (I) cont..

- CTLE behavioral model is defined with the following equation and related parameters, comprehending both AC and DC gains

$$H_{CTLE}(s) = A_{DC}\omega_{p2} \frac{(s + \omega_{p1}A_{AC})}{(s + \omega_{p1})(s + \omega_{p2})}$$

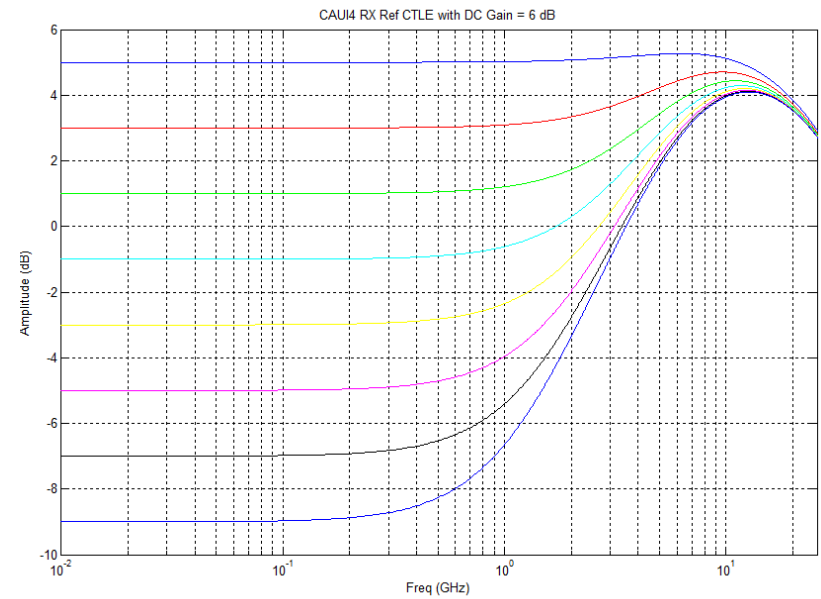
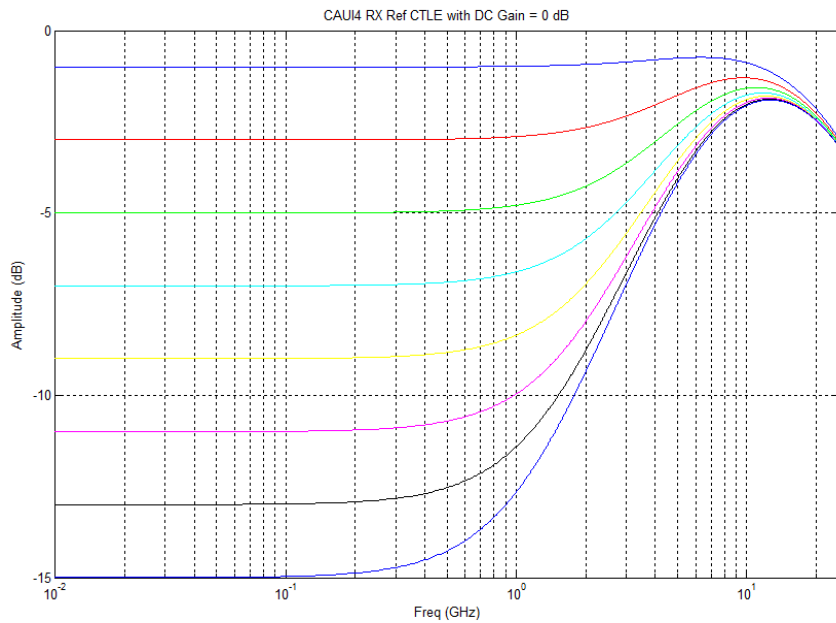
$$\omega_{p1} = 2\pi \times (0.25 \times 25.78 \text{ GHz})$$

$$\omega_{p2} = 2\pi \times 25.78 \text{ GHz}$$

$$A_{DC} = 10 \text{ dB}$$

$$A_{AC} = -1 \text{ to } -15 \text{ dB, with } 1 \text{ dB step size}$$

# Updated Behavioral CTLE Definition: Option (I) cont..



# Proposed RX Interference Tolerance Test: Option (II)

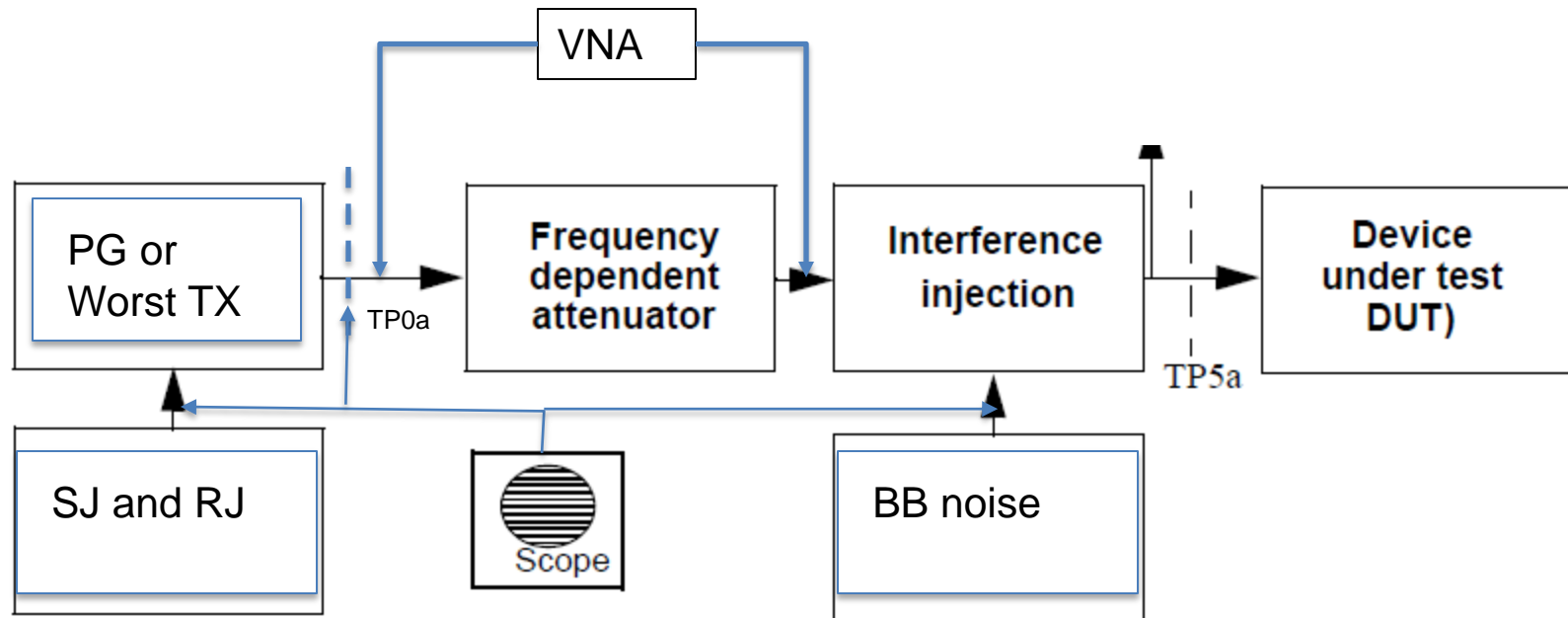
Table 83D-3 Receiver interference tolerance test parameters

Parameter	Test Value	Unit
Max BER	1e-15	
Applied peak-to-peak sinusoidal jitter	5 UI at 0.1 MHz, 0.05 UI at 10 MHz	UI
Applied broad-band noise	5.6 (15 dB IL), 3.4 (20 dB IL)	mv (rms)
Applied random jitter	0.364	ps (rms)
Channel Insertion loss at 12.89 GHz	15, 20	dB



# Proposed RX Interference Tolerance Test: Option (II) cont..

Receiver interference tolerance test setup and calibration



## Proposed CAUI4 Channel Characteristics Option (I)

- Use updated COM as the channel compliance tool
- COM of 2, and EH ( $1e-15$ ) of 30 mv are the passing/fail thresholds
- EH ( $1e-15$ ) is the distance of two points at a probability level of  $1e-15$  on the distribution defined by Eq. 93A-43

# Proposed CAUI4 Channel Characteristics Option (I), cont..

Table 83D-5—Channel operating margin parameters

Parameter	Symbol	Value	Units
Signaling rate	$f_b$	25.78125	GBd
Maximum start frequency	$f_{min}$	0.05	GHz
Maximum frequency step	$\Delta f$	0.01	GHz
Device package model Single-ended device capacitance Transmission line length Single-ended board capacitance	$C_d$ $Z_p$ $C_b$	2e-4 6 1.5e-4	nF mm nF
Single-ended reference resistance	$R_o$	50	ohms
Single-ended termination resistance	$R_d$	55	ohms
Receiver 3 dB bandwidth	$f_r$	$0.75 \times f_b$	GHz
Transmitter equalizer, pre-cursor coefficient	$c(-1)$	0 -0.07 -0.14	— — —
Transmitter equalizer, post-cursor coefficient	$c(1)$	0 -0.09 -0.18	— — —
Continuous time filter, DC and AC Gains Minimum value Maximum value Step size	$A_{DC}$ $A_{AC}$	$A_{DC}$ 10 $A_{AC}$ -1, -15, 1	dB dB dB
Transmitter differential peak output voltage Victim Far-end aggressor Near-end aggressor	$A_v$ $A_f$ $A_n$	0.4 0.4 0.6	V V V
Number of signal levels	$L$	2	—
Number of samples per unit interval	$M$	32	—
Decision feedback equalizer (DFE) length	$N_b$	4	UI
Normalized DFE coefficient magnitude limit	$b_{max}$	1	—
Random jitter, RMS	$\sigma_{RJ}$	0.009375	UI
Dual-Dirac jitter, peak	$A_{DD}$	0.07	UI
One-sided noise spectral density	$\eta_o$	5.2e-8	V <sup>2</sup> /GHz
Target detector error ratio	$DER_0$	$10^{-15}$	—

## Proposed CAUI4 Channel Characteristics Option (II)

- Define the channel impairment limits and use them to define the channel characteristics w/o the use of Ref TX and RX

Table 83D-5 Channel characteristic parameters

Parameter	Test Value	Unit
IL at Nyquist (12.89 GHz)	15, 20	dB
Peak_MDXTK_interference	25.8	mv
Peak_MDNEXT_interference	24.8	mv
Peak_MDFEXT_interference	2.7	mv
ICN	5.6 (15 dB) 3.4 (20 dB)	mv (rms)
ILD	0.3	dB (rms)
ILD_peak	+/-1.2	dB ( f <=Nyquist)
ICR (dB, at Nyquist)	17	dB

## Proposed CAUI4 Channel Characteristics Option (II) cont..

- Definitions for parameters in proposed Table 83D-5 are the same as those defined in reference [5], Clause 10 and 12

# References

[1]: [http://www.ieee802.org/3/bm/public/jan13/li\\_01\\_0113\\_opt\\_x.pdf](http://www.ieee802.org/3/bm/public/jan13/li_01_0113_opt_x.pdf)

[2]: [http://www.ieee802.org/3/bm/public/mar13/li\\_01\\_0313\\_opt\\_x.pdf](http://www.ieee802.org/3/bm/public/mar13/li_01_0313_opt_x.pdf)

[3]: [http://www.ieee802.org/3/bm/public/may13/li\\_01a\\_0513\\_opt\\_x.pdf](http://www.ieee802.org/3/bm/public/may13/li_01a_0513_opt_x.pdf)

[4]: [http://www.ieee802.org/3/bm/public/jul13/mli\\_01\\_0713\\_opt\\_x.pdf](http://www.ieee802.org/3/bm/public/jul13/mli_01_0713_opt_x.pdf)

[5]: “Common Electrical I/O (CEI) - Electrical and Jitter Interoperability agreements for 6G+ bps, 11G+ bps and 25G+ bps I/O”, IA # OIF-CEI-03.0, Clause 10, 12

# Acknowledgements

- The author would like to thank Jeremy Buan, Richard Melitz, Ali Ghiasi, Ryan Latchman, Hsinho Wu, Masashi Shimanouchi for discussions or assistants.