CAUI-4 Ad hoc

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Agenda

- Patent Policy: The meeting is an official IEEE ad hoc. Please review the patent policy at the following site prior to the meeting.
  http://www.ieee802.org/3/patent.html
- TBD for CAUI-4 chip-to-chip
  - COM Update [moore_01_073013_caui]
  - Transmitter Eye Mask Measurement
  - Transmit Equalizer
  - Rx Interference

Transmit wave form

Table 83D–1—CAUI-4 transmitter characteristics at TP0a

Parameter	Subclause Reference	Value	Units
Signaling rate per lane (range)	83E.3.1.1	25.78125 ± 100 ppm	GBd
Differential peak-to-peak output voltage (max) Transmitter disabled Transmitter enabled	83D.3.1.1	 30 1200	mV
Common-mode voltage (max)	83D.3.1.1	1.9	V
Common-mode voltage (min)	83D.3.1.1	0	V
Common-mode AC output voltage (max, RMS)	83D.3.1.1	12	mV
Differential output return loss (min)	83D.3.1.2	Equation (83D–2)	dB
Common-mode output return loss (min)	83D.3.1.2	Equation (83D–3)	dB
Transition time (min, 20% to 80%)	83D.3.1.3	8	ps
Output Jitter (max) Random jitter Deterministic jitter Total jitter	83D.3.1.4	 0.15 0.15 0.28	UI
Transmitter eye mask definition X1	83D.3.1.5	0.14	UI
Transmitter eye mask definition X2	83D.3.1.5	0.4	UI
Transmitter eye mask definition Y1	83D.3.1.5	200	mV
Transmitter eye mask definition Y2	83D.3.1.5	600	mV
Minimum de-emphasis[a] Post Cursor Pre Cursor	83D.3.1.6	 TBD TBD	dB

[a]Independent of optimal setting used for transmitter jitter and output waveform measurements.

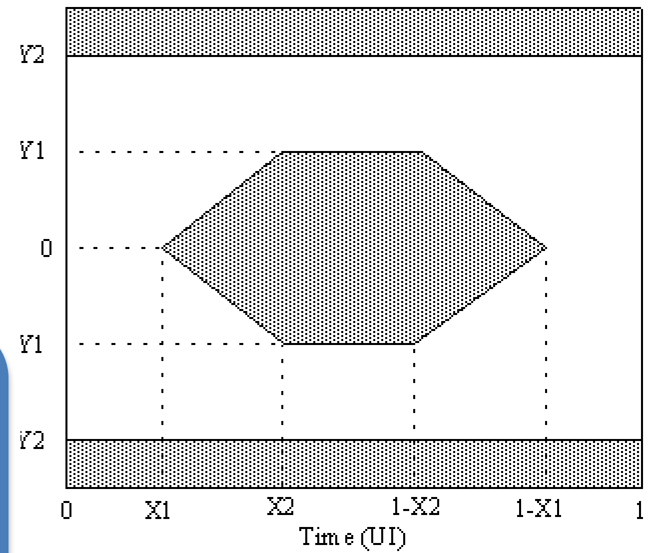

Figure 83D–7—Transmitter eye mask

Measurement of Transmit Jitter

Transmitter output jitter

- The components of the transmitter output jitter is defined in this subclause: total jitter (TJ), deterministic jitter (DJ), and random jitter (RJ).
- Transmitter output is measured at TP0a as defined in . All co-propagating and counter propagating CAUI-4 lanes are active during transmitter output jitter testing. Counter propagating lanes have a target differential peak-to-peak amplitude of 800 mV and transition time of 8 ps. All counter-propagating signals shall be asynchronous to the co-propagating signals using pattern 5 (with or without FEC encoding) pattern 3 or a valid 100GBASE-R signal. For the case of pattern 3, with at least 31 UI delay between the PRBS31 patterns on one lane and any other lane.
- The effect of a single-pole high-pass filter with 3 dB frequency of 10 MHz is applied to the jitter. The test pattern for jitter measurements is PRBS31. The voltage threshold for the measurement of BER or crossing times is the mid-point (0 V) of the AC-coupled differential signal.

Total jitter

- The total jitter (TJ) of a signal is defined as the range (the difference between the lowest and highest values) of sampling times around the signal transitions for which the BER at these sampling times is greater than or equal to 10^{-15}.
- Total jitter for a CAUI-4 chip-to-chip transmitter is than or equal to 0.28 UI and is measured with optimal transmit equalizer setting.

Deterministic and random jitter

- The random jitter (RJ) of a signal is defined to be the difference between the TJ and DJ. DJ is derived from measured jitter distribution as follows
  - Measure the jitter Jn which is defined to be the interval that includes all but 10^{-n} of the jitter distribution. If measured by plotting BER vs. decision time, it is the time interval between the two points with BER of $10^{-n}/4$. Measure two values: J9 and J5
  - For each Jn determine the associated Qn from the inverse normal cumulative probability distribution adjusted for an assumed transition density of 0.5. Q9 is 5.998 and Q5 is 4.265
  - Calculate the effective DJ as shown in
- Deterministic jitter is less than or equal to 0.15 UI. Random jitter is less than or equal to 0.15 UI.

Measurement Methodology for Eye Mask – Leverage 83E

Transmitter output waveform

- The eye mask show in is defined at a BER of 10^{-15}, using the methodology described in TBD. Transmitter equalizer may be adjusted for optimum mask results.

TBD section:

- Transmit output waveform in CAUI-4 chip-to-chip are measured using a fourth-order Bessel-Thomson low-pass filter response with 33 GHz 3 dB bandwidth. X1 is measured using the methodology described in 83D.3.1.4 where X1 = TJ/2. Y2 is measured using the methodology described in 83D.3.1.1 . Y1 is measured using the following procedure using a PRBS9 waveform:
  - Capture the PRBS9 pattern using a clock recovery unit with 3 dB tracking bandwidth of 10 MHz and maximum peaking of 0.1 dB and a minimum sampling rate of 3 samples per bit. Collect sufficient samples equivalent to at least 4 million bits to allow for construction of a normalized cumulative distribution function (CDF) to a probability of 10^{-6} without extrapolation.
  - Use the differential signal from step 1 to construct the CDF of the signal amplitude at X2, midpoint (0.5) and 1-X2, for both logic 1 (CDF1) and logic 0 (CDF0), as a distance from the center of the eye. Calculate the eye height for each point (EH6) as the difference in amplitude between CDF1 and CDF0 with a value of 10^{-6}. CDF0 and CDF1 are calculated as the cumulative sum of histograms of the amplitude at the top and bottom of the eye normalized by the total number of sampled bits. For a well balanced number of ones and zeros the maximum value for CDF0 and CDF1 will be 0.5.
  - Apply the Dual-Dirac and tail fitting techniques to CDF1 and CDF0 to estimate the noise at X2, 0.5 and 1-X2 points. Calculate the best linear fit in Q-scale over the range of probabilities of 10^{-4} and 10^{-6} of CDF1 and CDF0 to yield relative noise one (RN1) and relative noise zero (RN0). The eye height for plotting against the eye mask at X2, 0.5, and 1-X2 is then given by
  - EH15 = EH6 -3.19 x (RN0 + RN)
- where
  - *EH15 peak*	*is the eye height extrapolated to 10^{-15} probability*
  - *EH6*	*is the eye height at 10^{-6} probability*
  - *RN1 is the RMS value of the noise estimated from CDF1*
  - *RN0 is the RMS value of the noise estimated from CDF0*

Transmit equalizer

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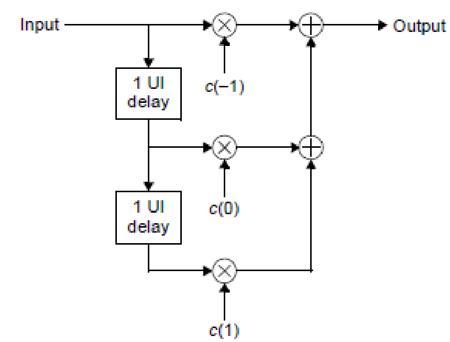
Minimum de-emphasis[a] Post Cursor Pre Cursor	83D.3.1.6	 TBD TBD	dB

[a]Independent of optimal setting used for transmitter jitter and output waveform measurements.

- **Transmitter de-emphasis range**
- The CAUI-4 chip-to-chip transmitter includes programmable equalization to compensate for the frequency-dependent loss of the channel and to facilitate data recovery at the receiver. The functional model for the transmit equalizer is the three tap transversal filter shown in TBD. The minimum pre cursor equalization (c(-1)) is TBD. The minimum post cursor equalization (c(1)) is TBD.
- The transmitter output equalization is characterized using the procedure described in TBD.



Transmit equalization

- ghiasi_010713: post cursor of 6dB in 0.5dB steps and pre is nice to have with 3dB in 0.5dB steps
- OIF MR

14.3.1.6 Transmitter output waveform requirements

The transmitter shall include an equalizer defined as:

$$H(Z) = C_{-1} + C_0 z^{-1} + C_1 z^{-2} \quad (14\text{-}10)$$

14.3.1.6.1 Summary of requirements

The normalized amplitudes of the coefficients of the transmitter equalizer (computed per 14.3.1.6.2) shall meet the requirements in Table 14-9.

Table 14-9. Coefficient range and step size

Coefficient	Normalized Amplitude		Normalized Step Size (%)
	Min (%)	Max (%)	
C_{-1}	-20	0	1.25 to 5
C_1	-25	0	1.25 to 5
C_0	40	100	1.25 to 5

Transmit equalizer characterization (In CL93)

- The transmitter output waveform is characterized using the procedure described in 85.8.3.3. The parameters of the linear pulse fit and equalizer are summarized in Table 93–5.

Table 93–5—Linear fit pulse and equalizer parameters

Description	Symbol	Value	Units
Linear fit pulse length	N_p	8	UI
Linear fit pulse delay	D_p	2	UI
Equalizer length	N_w	8	UI
Equalizer delay	D_w	2	UI

Steady-state voltage and linear fit pulse peak

The steady-state voltage *vf is defined to be the sum of the linear fit pulse p(k) divided by M (refer to 85.8.3.3* step 3). The steady-state voltage shall be greater than or equal to 0.4 V and less than or equal to 0.6 V after the transmit equalizer coefficients have been set to the values used for transmit wave form evaluation. The peak value of *p(k) shall be greater than 0.8 × vf after the transmit equalizer coefficients have been set to* the values used for transmit wave form evaluation .

Linear fit error

For any configuration of the transmit equalizer, the RMS value of the error between the linear fit and the measured waveform, *e(k), normalized to the peak value of the linear fit pulse, p(k), shall be less than or* equal to 0.037.