Transmitter Characteristics (83D.3.1)

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Transmit equalizer

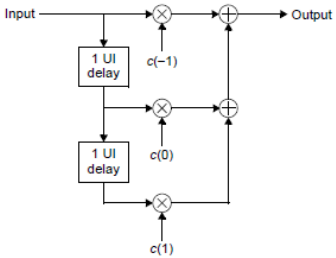


Table 83D–1—CAUI-4 transmitter characteristics at TP0a§

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.§

Minimum transmit equalizer range:
Change TBD to tables shown on right

- **Transmitter equalizer 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)) supported is shown in table TBD.

Pre Cursor Equalizer Setting	Pre Cursor Equalization Value
1	0dB +/- 1dB
2	1.5dB +/-1dB
3	3dB +/-1dB

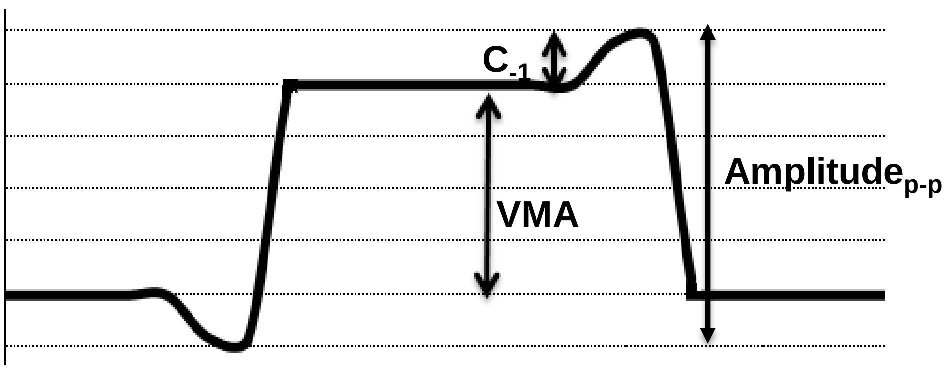
- The minimum post cursor equalization (c(1)) support is shown in table TBD

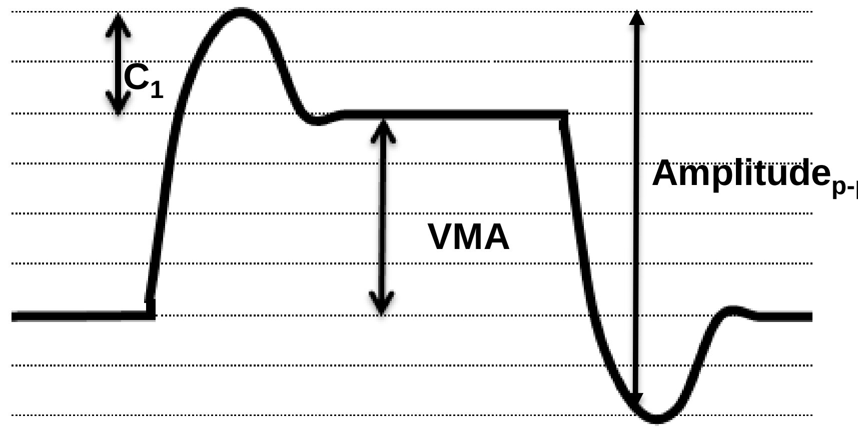
Post Cursor Equalizer Setting	Post Cursor Equalization Value
1	0dB +/- 1dB
2	2dB +/- 1dB
3	4dB +/-1dB
4	6dB +/-1dB

- The transmitter output equalization is characterized using the procedure described in TBD.

Transmit equalization characterization

- Measure VMA per 86A.5.3.5 using square wave or PRBS9 defined in Table 86-11 using a test system with a fourth-order Bessel-Thomson low-pass response with 33 GHz 3 dB bandwidth
- Set post-cursor equalization to the zero setting. Measure pre-cursor amplitude defined as the peak amplitude before a transition. Define C_0, C_{-1} as normalized main tap, and pre-cursor values per equations A and B. Calculate pre-cursor value for each pre-cursor setting using equation C
- Set pre cursor equalization to the zero setting. Measure post-cursor amplitude defined as the peak amplitude after a transition. Define C_0, C_1 as normalized main tap, and post-cursor values per equations D and E. Calculate post-cursor value for each post-cursor setting using equation F





Equation A $|C_0| = 1 - |C_{-1}|$

Equation B $|C_{-1}| = |C_0| - \frac{VMA}{Amplitude_{p-p}}$

Equation C $\Pr ecursor\_value = 20 * LOG10\left(\frac{1}{C_0 - C_{-1}}\right)$

Equation D $|C_0| = 1 - |C_1|$

Equation E $|C_1| = |C_0| - \frac{VMA}{Amplitude_{p-p}}$

Equation F $\Pr ecursor\_value = 20 * LOG10\left(\frac{1}{C_0 - C_1}\right)$

Transmit wave form

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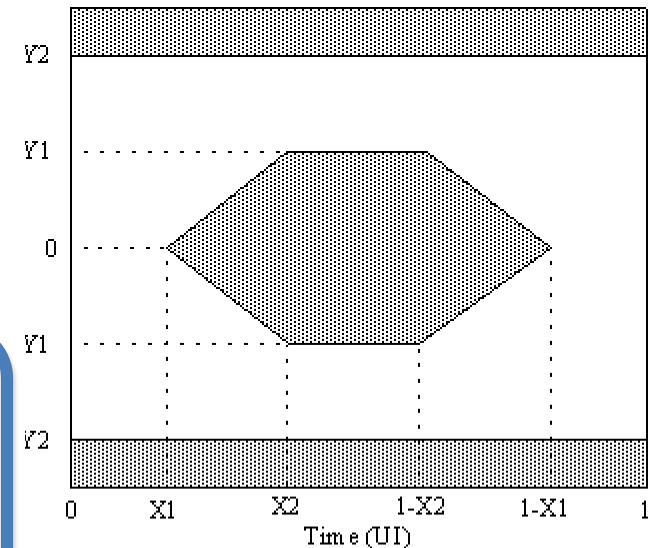

Figure 83D–7—Transmitter eye mask§

Measurement of Transmit Jitter

Transmitter output jitter

- The components of the transmitter output jitter are defined in this subclause: total jitter (TJ), deterministic jitter (DJ), and random jitter (RJ).
- Transmitter output is measured at TP0a as defined in 83D.2. 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. Patterns 3 and 5 are defined in Table 86-11. 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 PRBS9. 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 less 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 the 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 83D-4

$$DJ = \frac{Q9 \times J5 - Q5 \times J9}{Q9 - Q5} \qquad \text{83D-4}$$

- 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:

- The transmit output waveform in CAUI-4 chip-to-chip is measured using a fourth-order Bessel-Thomson low-pass filter response with 33 GHz 3 dB bandwidth. Compliance with X1 is verified using the methodology described in 83D.3.1.4 where the maximum TJ is 2 x X1. Compliance with Y2 is verified using the methodology described in 83D.3.1.1 . Compliance with Y1 is verified using the following procedure with 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 + RN1)
- 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*