VEC spec for 50GAUI-1 C2M and 100GAUI-2 C2M

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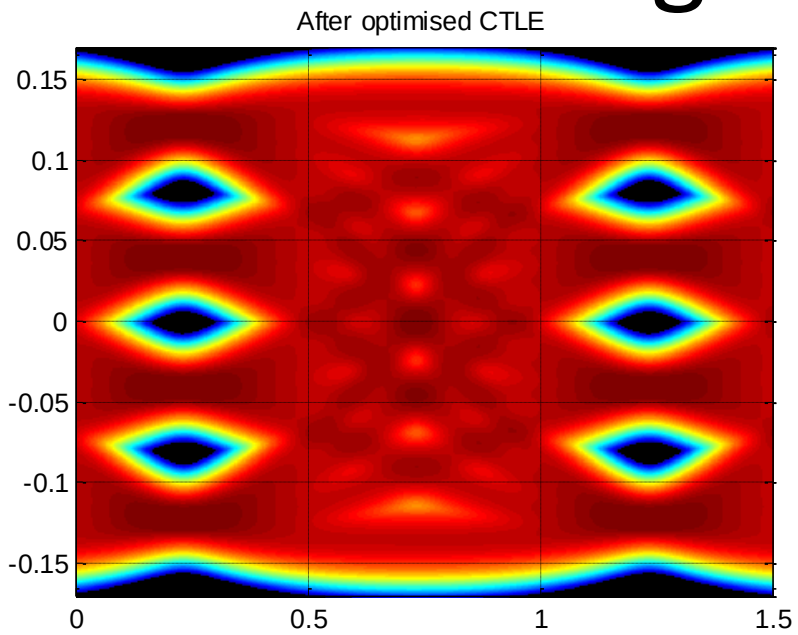
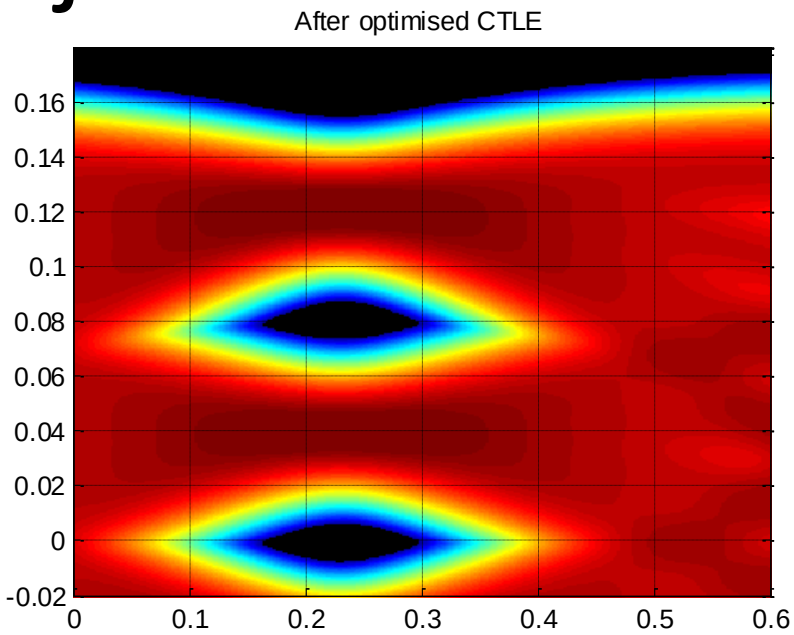
Introduction

- Annex 135G 50GAUI-1 C2M and 100GAUI-2 C2M follows Annex 120E 200GAUI-4 C2M and 400GAUI-8 C2M
- It was hoped that eye height and width after CTLE would enforce a receivable signal
- Eye width is relative to 1 UI, eye height is not relative to anything about the signal
- In the transmit direction (host to module) this allows unreasonable signals
- The issue was presented in http://ieee802.org/3/bs/public/adhoc/elect/05Oct_17/dawe_01b_100517_elect.pdf
- The issues and technical solution are the same here. Comment 30 (slide 9) has the same remedy

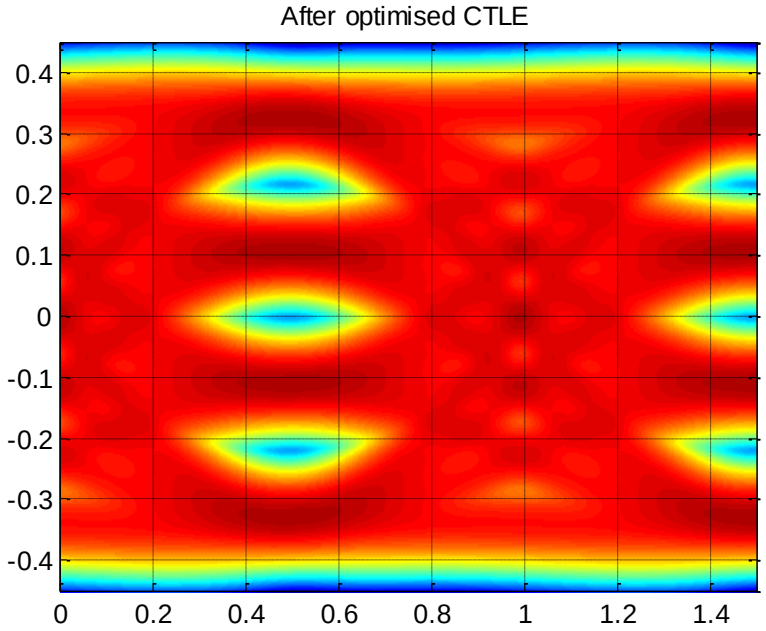
Design objective

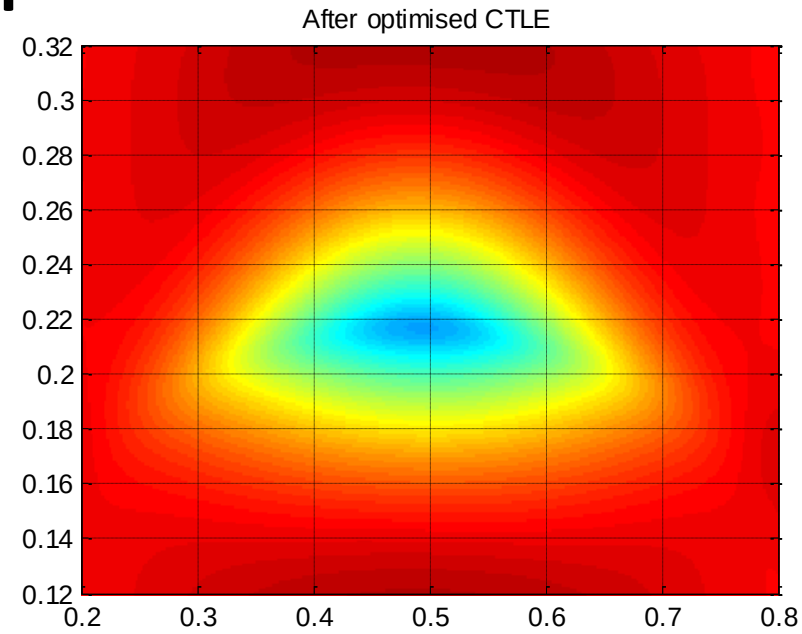




- This is close to the intended worst case host output
  - Seen through the CTLE ~0.31 V pkpk after CTLE
- Simulation of the module stressed input signal with 12.2 dB channel and a nominally 900 mV driver. Eye height is at the minimum 32 mV. **VEC is 8 dB** (a finding, not a target)

What the spec allows



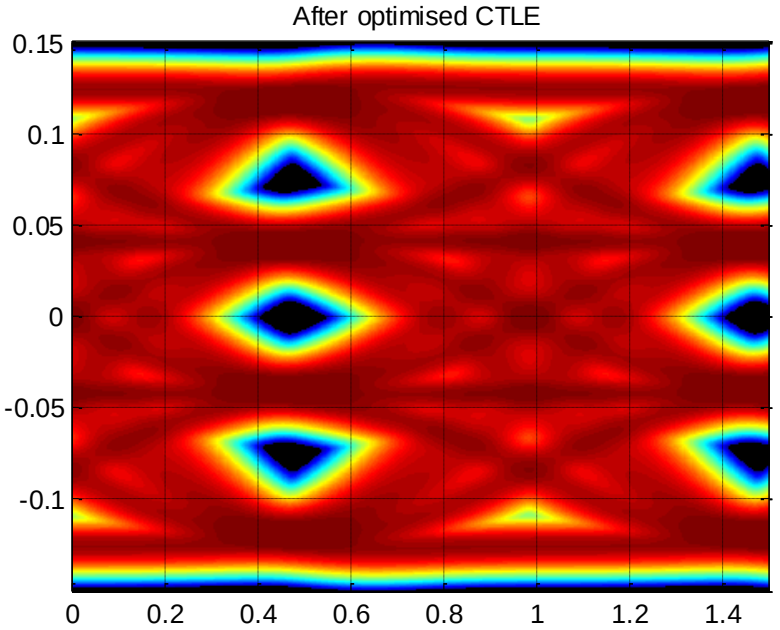


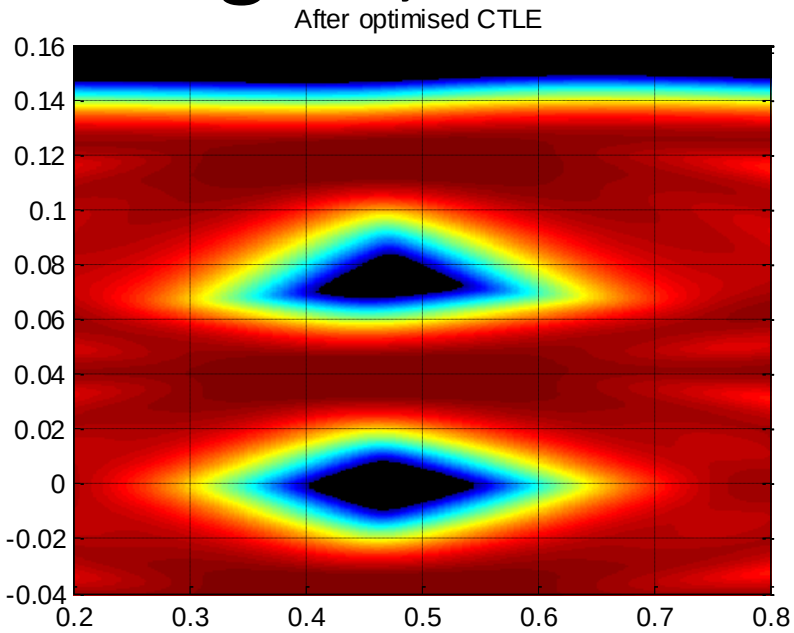
- This output from a low loss host is allowed by the spec. The signal is more than 2.5x bigger (0.83 V pk-pk vs. 0.31 V after CTLE) but the eye height (usable opening) is still only 35 mV for eye width at minimum. This signal's **VEC is 15.8 dB**.
  - It was hoped that the eye width spec would enforce a better eye height. But it doesn't do so significantly – a host could have less UBJ and more noise than this one, taking the eye height closer to the minimum 32 mV

Why is this signal bad?

- Receiving a small inner eye in a big signal stresses tuning and linearity "dynamic range" issues that are beyond the module stressed input test
- Very blurred eye, i.e. ratio Vpkpk / eye height is too large
  - Next slide 7 shows the low loss module stressed input test; the high loss case is on slide 4
  - A module stressed input signal would not be like slide 5 which has much worse noise or ILD than the stressed eye generator

Module stressed input signal, low loss





- Eye height 31.7 mV, width 0.219 UI (target is 32, 0.22)
- **VEC is 7.9 dB** CTLE is at 2.5 dB ~0.28 V pk-pk after CTLE
- Nominally 342 mV at driver, no emphasis. Much cleaner and less pk-pk swing than host is allowed
  - (as expected / intended)
- In this case, the 1e-5 contour is in the green region. Because this is a pdf not a cdf, it won't be quite the same in other cases

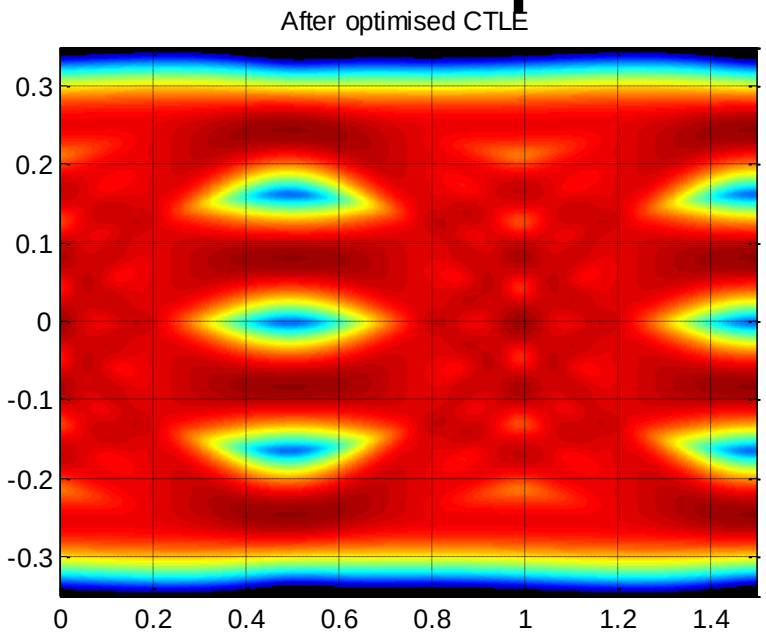
Remedy

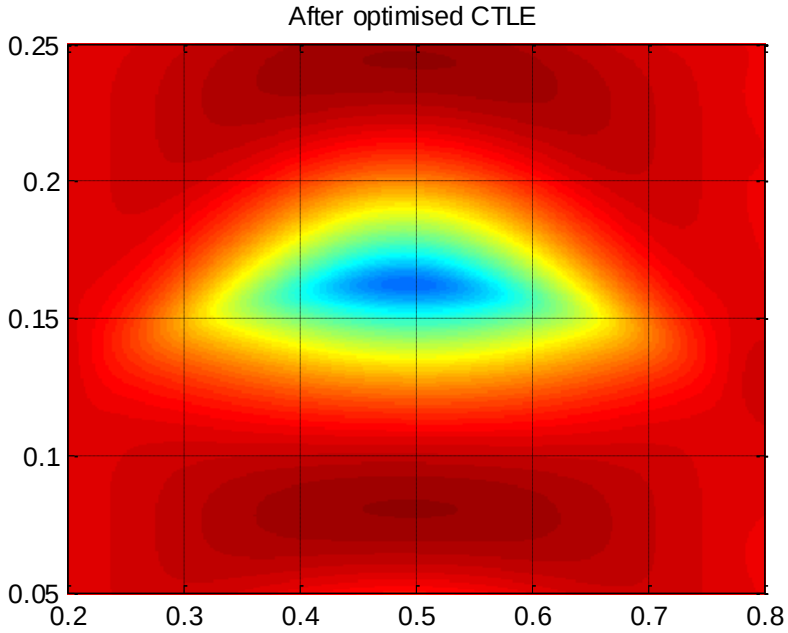
- The module stressed input signals (slides 4, 7) have VEC around **8 dB**
- The bigger, blurry, but still near minimum height, eye (slide 5) has a VEC about **16 dB**
- A low loss host might have a worse VEC than a high loss host, but not 8 dB worse
- **Limit the host output VEC to 12 dB**
  - There is no need to do the same for the module output because the signal swing is limited before the host loss and the minimum eye height is enforced both before and after it
  - Use VEC rather than Vpkpk / eye height because we know how to specify and measure it
    - See P802.3bs D2.0 120E.4.2.1 Vertical eye closure
    - This was removed for D2.1 because it was not needed for the module output as well as the far end eye spec (D2.0 comment 173)
- This change could be made in P802.3cd sponsor ballot

P802.3cd Draft 2.2 comment 30

- *Cl* **135G** *SC* **135G.3.1** *P* **375** *L* **22** *#* 30 *Type* **TR**
- As shown in http://ieee802.org/3/bs/public/adhoc/elect/05Oct_17/dawe_01b_100517_elect.pdf there is a need for an additional spec to protect the module from e.g. very noisy hosts, and a max VEC spec provides worthwhile protection.
- *SuggestedRemedy*
- Here, add a requirement for VEC, max 12 dB. In 135G.4, add definition of VEC, which was in P802.3bs D2.0 120E.4.2.1 (the AVs were illustrated in Figure 120E-13, although they could be on Fig 120E-14 and the text under what was equation 120E-3 is clear enough so we don't have to add them to the figure).
- Add PICS to 135G.5.4.1.
- Dawe, Piers Mellanox

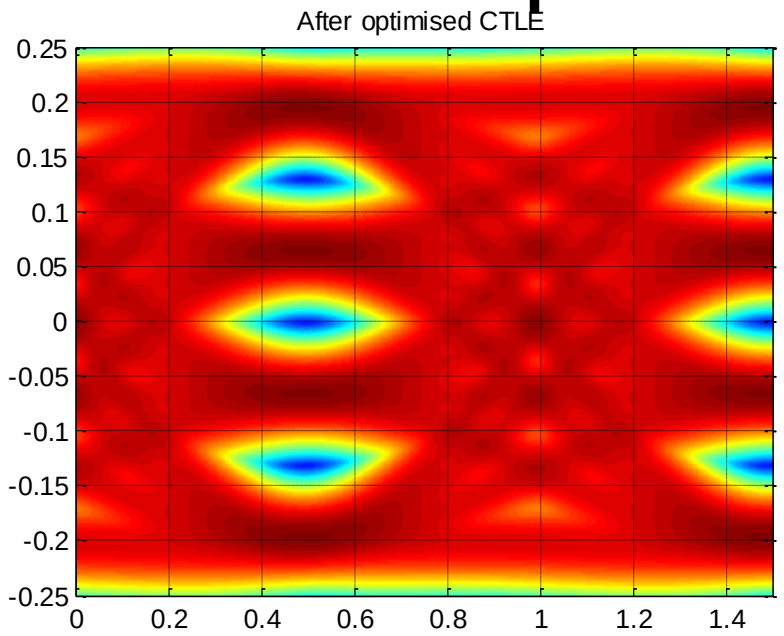
What the spec would allow – 14 dB

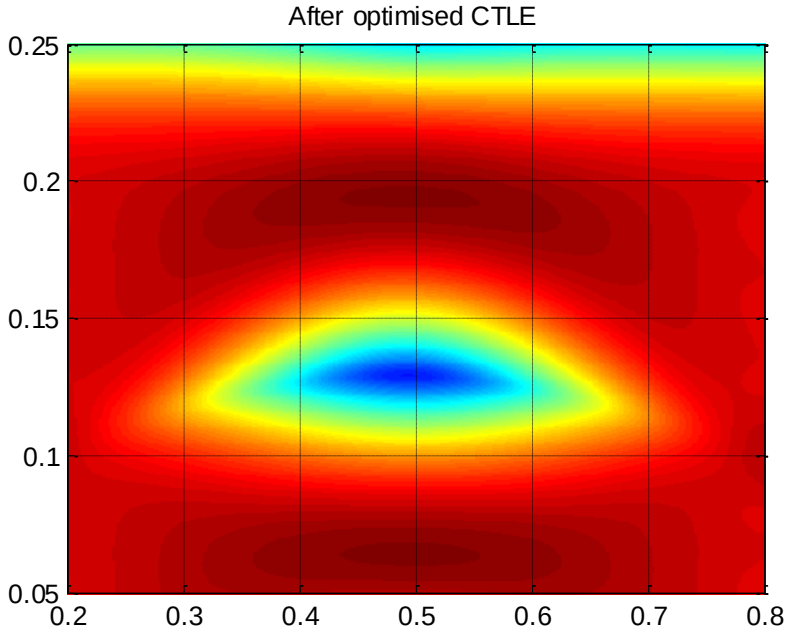




- This signal 0.67 V pk-pk after CTLE
- **VEC is 13.8 dB**
- Eye height is 33 mV

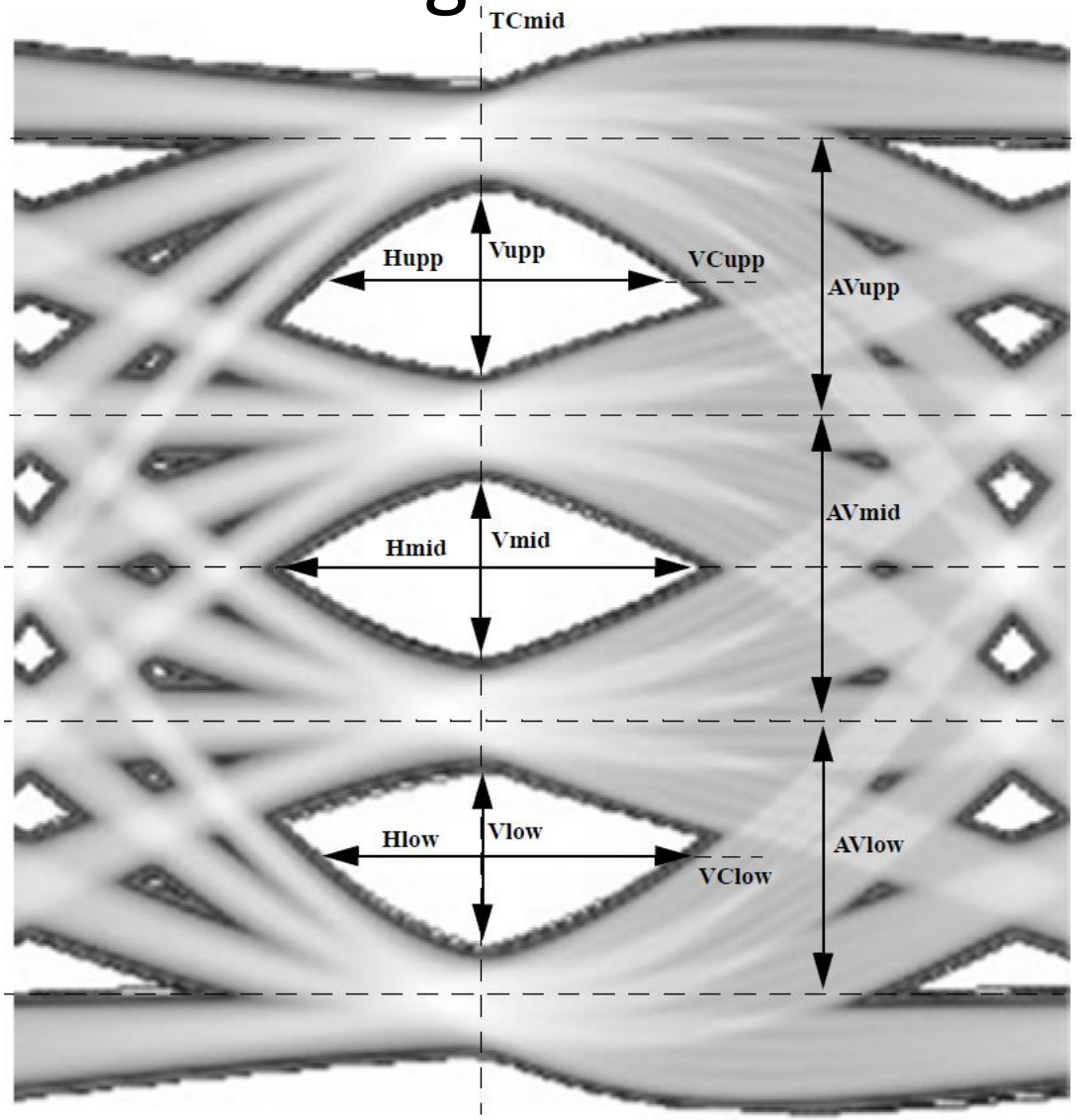
What the spec would allow – 12 dB





- This signal 0.49 V pk-pk after CTLE
- **VEC is 12.0 dB**
- Eye height is 32.6 mV

Figure showing AVx used for calculating VEC



See example equation defining VEC on next slide

135G3.1.1 Vertical eye closure

- Vertical eye closure is defined for the host output by Equation (135G–1).
- *VEC* = 20log10(max[*Avupp*/*Vupp*, *Avmid*/*Vmid*, *Avlow*/*Vlow*]) (135G–1)
- where
- *VEC* is vertical eye closure in dB;
- *AVupp* is the eye amplitude of the upper eye of the differential equalized signal. Eye amplitude is defined for the upper eye as the mean value of the +1 signal minus the mean value of the +1/3 signal within 0.025 UI of time TCmid;
- *Vupp* is the 10^{-5} eye height of the upper eye determined in 120E.4.2;
- *AVmid* is the eye amplitude of the middle eye of the differential equalized signal. Eye amplitude is defined for the middle eye as the mean value of the +1/3 signal minus the mean value of the –1/3 signal within 0.025 UI of time TCmid;
- *Vmid* is the 10^{-5} eye height of the middle eye determined in 120E.4.2;
- *AVlow* is the eye amplitude of the lower eye of the differential equalized signal. Eye amplitude is defined for the lower eye as the mean value of the –1/3 signal minus the mean value of the -1 signal within 0.025 UI of time TCmid;
- *Vlow* is the 10^{-5} eye height of the lower eye determined in 120E.4.2.