TDECQ - optimizing time center of eye

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Problem

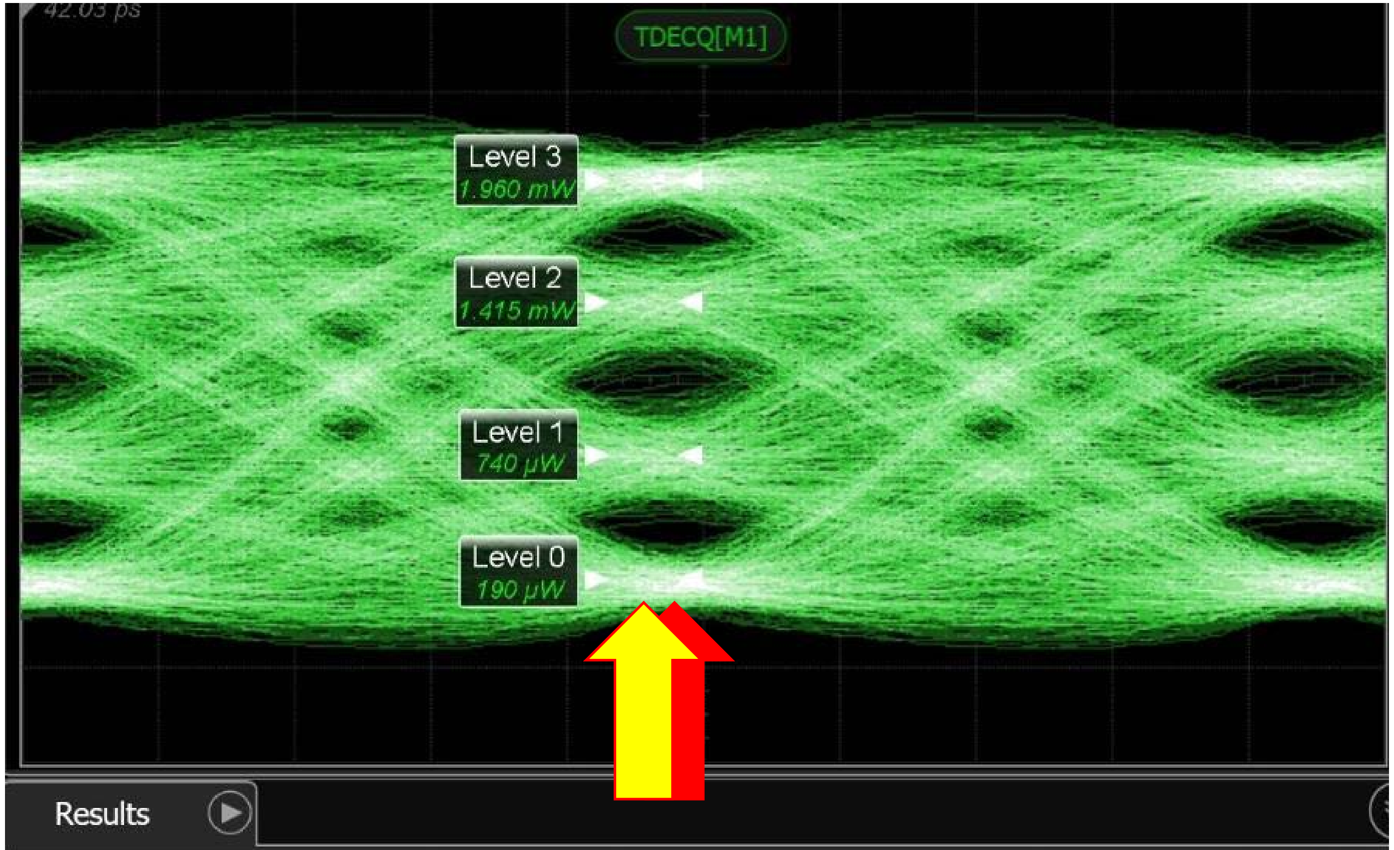
- The current definition for time centre of eye (“0.5 UI”) is based on the time average of the centre crossing points.
- This was OK for T/2 spaced reference equalizers, which would effectively optimize the equalized eye time-centre for best TDECQ.
- But it is not sufficient for a T spaced reference equalizer, which cannot optimize the time-centre of the equalized eye.
- PHYs with T-spaced equalizers are expected to optimize their sampling point, equivalent to optimizing the timing position of the histograms used to measure TDECQ.
- Therefore, the TEDCQ method should be allowed to optimize the timing position when measuring transmitter eyes, to avoid penalizing or excluding transmitters which have open eyes which are offset from the time average of the centre crossing points.

Suggested remedy

- In 121.8.5.3, replace the paragraph “Two vertical histograms are measured through the eye diagram, centered at 0.45 UI and 0.55 UI. Each of the histogram windows spans all of the modulation levels of the eye diagram, as illustrated in Figure 121–5. ” with “Two vertical histograms are measured through the eye diagram, nominally centered at 0.45 UI and 0.55 UI. Each of the histogram windows spans all of the modulation levels of the eye diagram, as illustrated in Figure 121–5. The precise time position of the 0.45 UI and 0.55 UI histograms may be adjusted (e.g. to minimize TDECQ), but the histograms must be spaced 0.1 UI apart.”

Illustration of the problem

- The yellow arrow shows where the time-centre of the eye is calculated to be, based on the current definition in D3.3
- Allowing the left and right histograms to shift to the right (to the red arrow) would reduce TDECQ, and would reflect the of capabilities of T spaced and T/2 spaced equalizer implementations..



Measurement		Current	Minimum	Maximum	Count
Linearity [RLM]	F1	0.918	0.918	0.918	1
Outer ER	M1	10.26 dB	10.26 dB	10.26 dB	1
Outer OMA	M1	1.7190 mW	1.7190 mW	1.7190 mW	1
TDECQ	F1	7.33 dB	7.33 dB	7.33 dB	1

Eye diagram from Marco Mazzini, Cisco

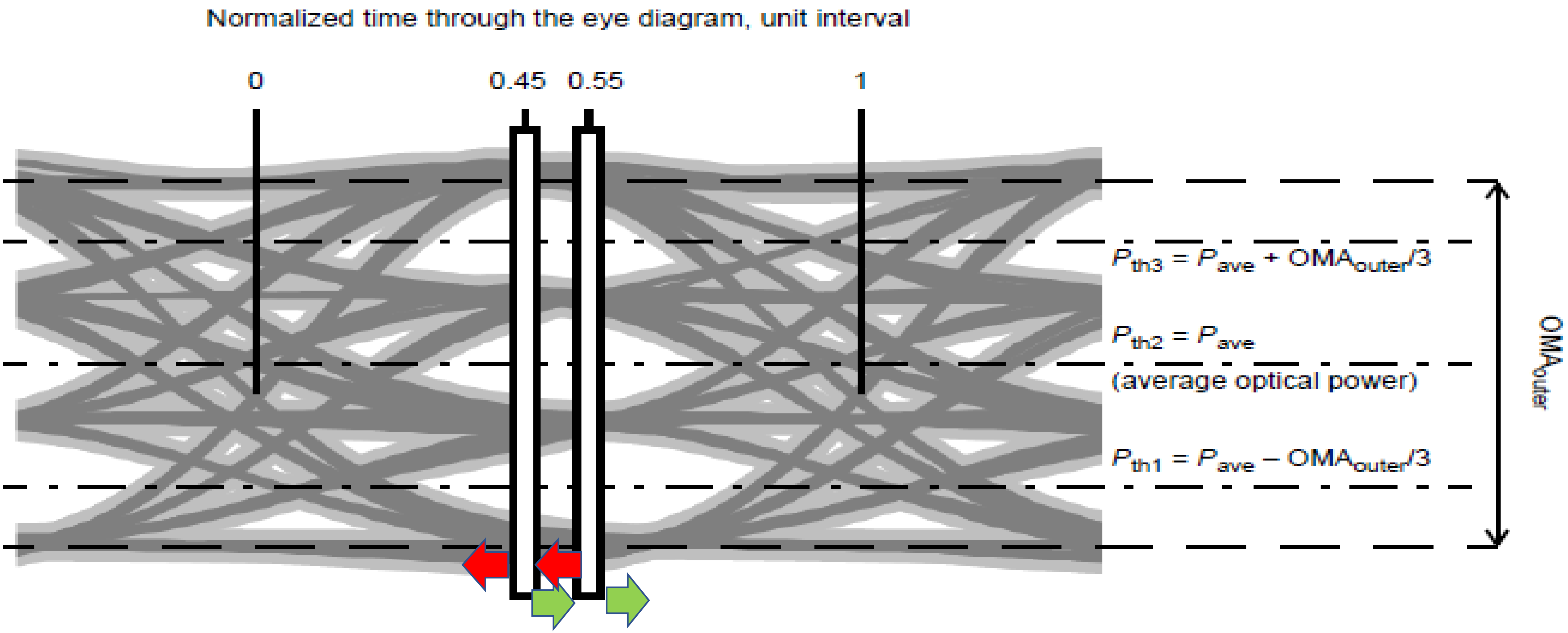


Figure 121–5—Illustration of the TDECQ measurement

The suggested remedy allows the pair of histograms to be adjusted left or right of their respective 0.45 and 0.55 UI positions, but still requires them to be spaced by 0.1 UI

Back up

121.8.5.3 TDECQ measurement method

This is the section of the draft which would change

The captured waveform is processed to find the largest noise that could be combined with the signal by an ideal reference receiver when optimally equalized by a reference equalizer. The optimal equalizer tap coefficients are dependent on the amount of noise that can be added to the signal, so finding the noise that can be added and the optimal equalizer setting is an iterative process. One way of doing this, using estimated PAM4 symbol error ratio as the figure of merit for the equalized signal, is described below.

The reference equalizer (specified in 121.8.5.4) is applied to the waveform. The sum of the equalizer tap coefficients is equal to 1. An eye diagram is formed from the equalized captured waveform.

The average optical power (P_{ave}) of the equalized eye diagram is determined, and the 0 UI and 1 UI crossing points are determined by the average of the eye diagram crossing times, as measured at P_{ave}, as illustrated in Figure 121–5.

Two vertical histograms are measured through the eye diagram, centered at 0.45 UI and 0.55 UI. Each of the histogram windows spans all of the modulation levels of the eye diagram, as illustrated in Figure 121–5.

Each histogram window has a width of 0.04 UI. Each histogram window has outer height boundaries which are set beyond the extremes of the eye diagram (so that no further samples would be captured by increasing the vertical separation of the height boundaries).