Actividad 10.1

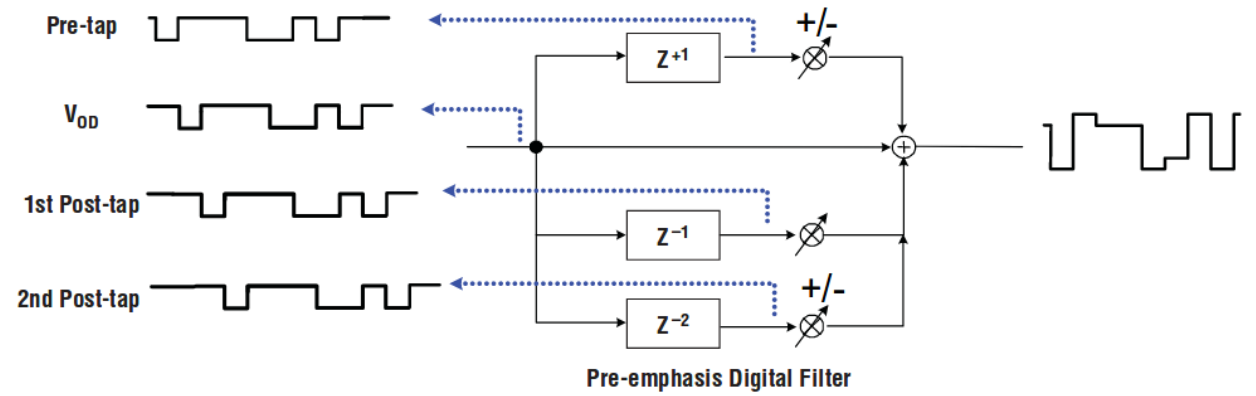
1) La siguiente información la extraje de la Application Note AN602 de Altera, donde presenta la codificación y decodificación de la Stratix IV GX.

Abstract: “This application note provides information about the transmitter pre-emphasis and receiver equalization behavior of Stratix IV GX devices. Specific examples demonstrate how an impacted signal is improved by these two features, on a time domain, a frequency domain, or both.

Therefore, a real pre-emphasis implementation generally works like a finite impulse response (FIR) filter with different “taps,” which refer to signals after different unit delays. In the frequency domain, pre-emphasis boosts the high-frequency energy on every transition in the data stream.”

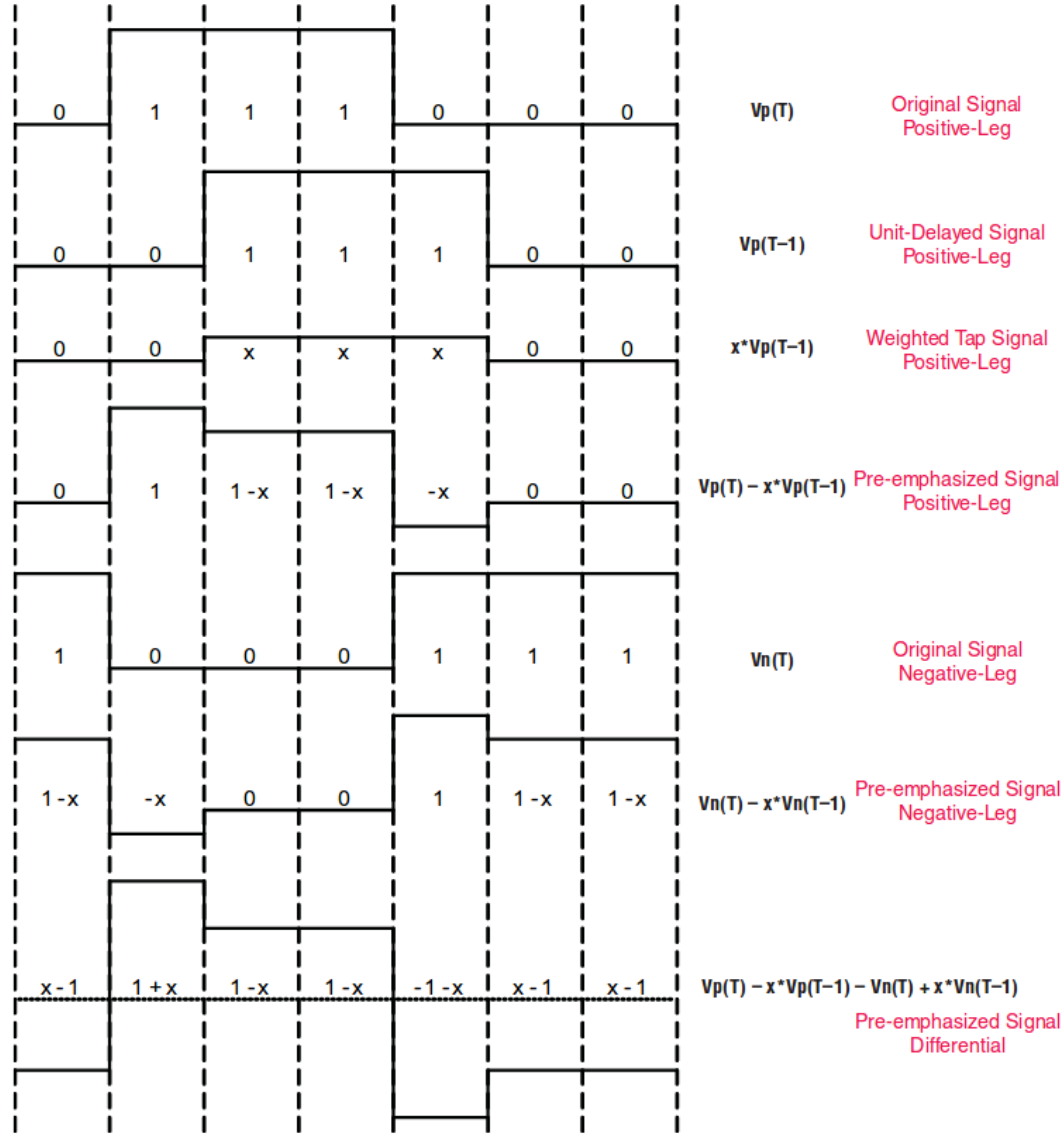
La siguiente figura representa la estructura del codificador

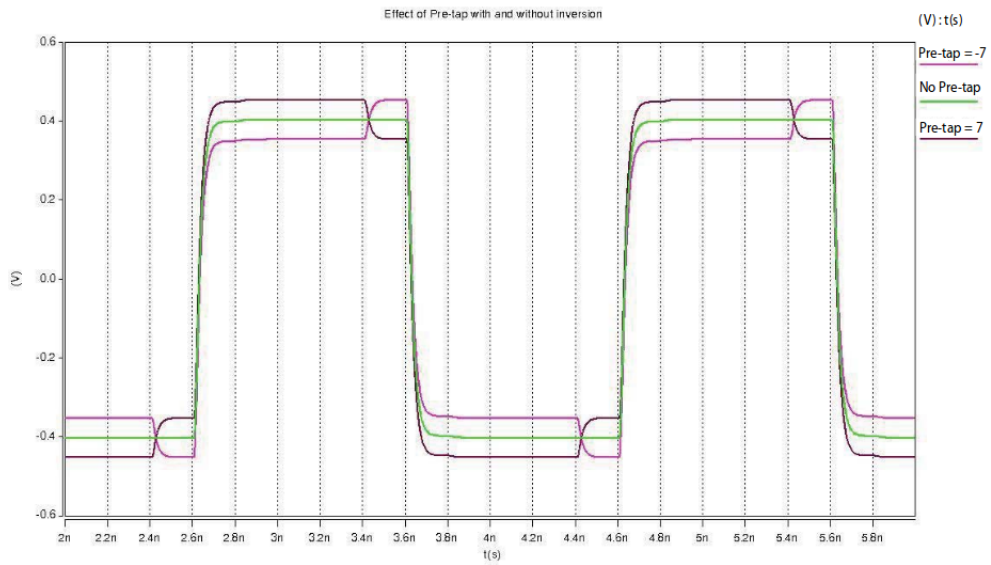
Figure 2. Pre-Emphasis Digital Filter



y lo que sigue es un pequeño ejemplo de cómo logran la pre-énfasis para una cierta señal

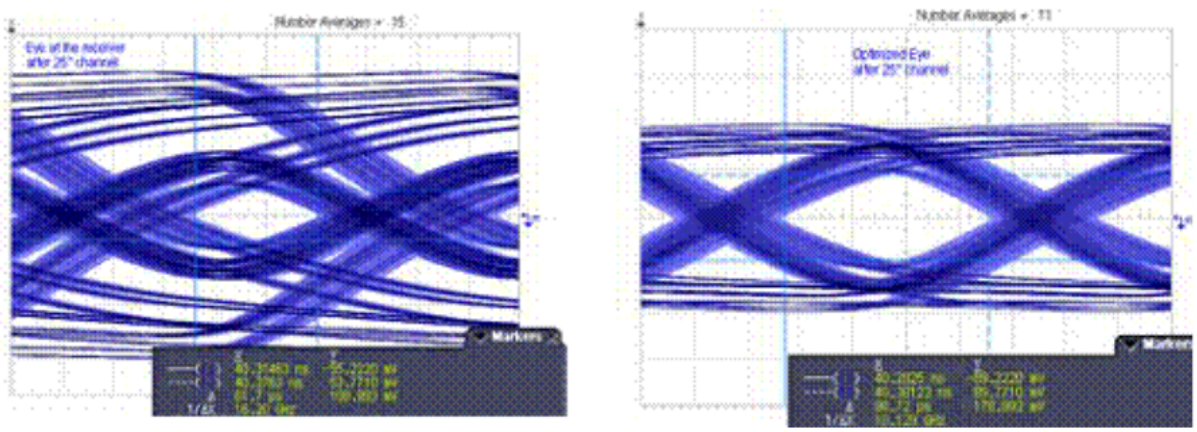
Figure 3. Pre-Emphasis Signal Generation





b) Stratix IV GX pre-tap simulation

Figure 8. Eye Diagram of Data Pattern without Taps and with Taps ***(Note 1)***



Pero todo lo bueno tiene sus contras al momento de correrlo de su punto óptimo de funcionamiento, y esto es lo que indican respecto a las limitaciones de esta característica.

Limitations of Pre-Emphasis

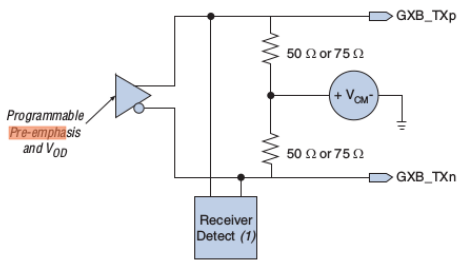
Pre-emphasis increases the signal edge rate, which increases the crosstalk on the neighboring channels. Meanwhile, because pre-emphasis emphasizes the transition bits and de-emphasizes the remaining bits, if there is any discontinuity along the channel, the reflection at the discontinuity is more complicated than without pre-emphasis. Because the impact of pre-emphasis on crosstalk and channel discontinuity is highly case-dependent, simulation is required to ensure the impact is minimal.

The pre-emphasis selection is also a key to the signal integrity at the receiver. Over-emphasis tends to degrade rather than help the receiver signal quality. Stratix IV GX devices offer multiple toolkits to determine or simulate the best pre-emphasis setting for a given backplane.

Por otro lado, en la CYIV-52001-3.7 de ALTERA presentando las características de la Cyclone IV, indican lo siguiente respecto a la funcionalidad de Pre-énfasis

"Programmable pre-emphasis—boosts high-frequency components in the transmitted signal to maximize the data eye opening at the far-end. The high-frequency components might be attenuated in the transmission media due to data-dependent jitter and intersymbol interference (ISI) effects. The requirement for pre-emphasis increases as the data rates through legacy backplanes increase."

Figure 1–11. Transmitter Output Buffer Block Diagram



Y este es otro ejemplo encontrado en una Application Note de una Altera Stratix II
http://www.molex.com/mx_upload/family/gbx_itrac_backplane_connector_system/wp-DesignCon2007.pdf

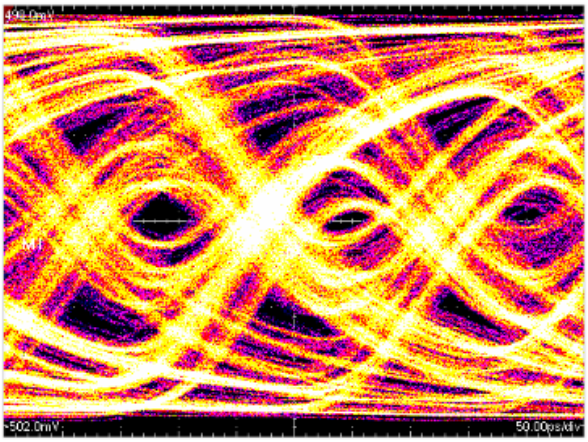


Figure 26a. Far End of 30" Backplane

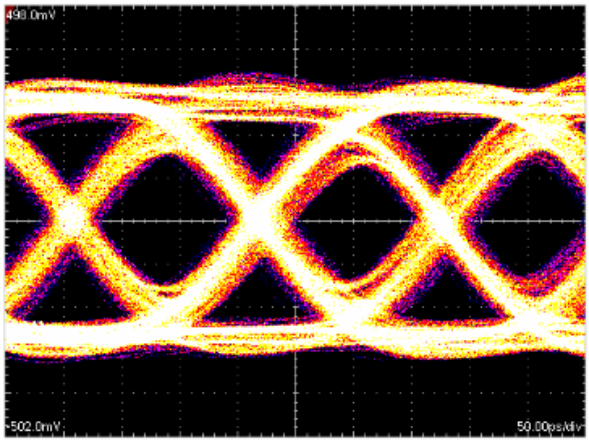


Figure 26b. Pre-Emphasized Eye at Far-End of 30" Backplane

2) Referencia de BER aceptables

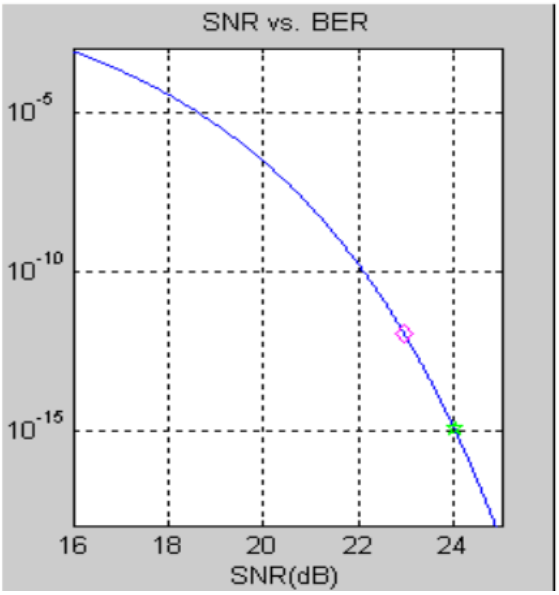
Acceptable BER	Measurement Time to Confirm
3 x 10-12	1 minute
5 x 10-14	1 hour
2 x 10-15	1 day
1 x 10-15	1 weekend
7 x 10-17	1 month
6 x 10-18	1 year

Referencia de BER sin ecualización de señales

$$SNR = \frac{d_{\min}^2}{\sigma^2}$$

$$\Pr_{err} \approx \frac{1}{2} erfc\left(\frac{\sqrt{SNR}}{2\sqrt{2}}\right)$$

•Approximately 24dB is required for an error rate of 10^{-15}



Con/Sin Pre-Énfasis
https://www.altera.com/content/dam/altera-www/global/en_US/pdfs/literature/an/an605.pdf

Figure 3. Measuring the Horizontal Eye Opening Using the EyeQ Feature

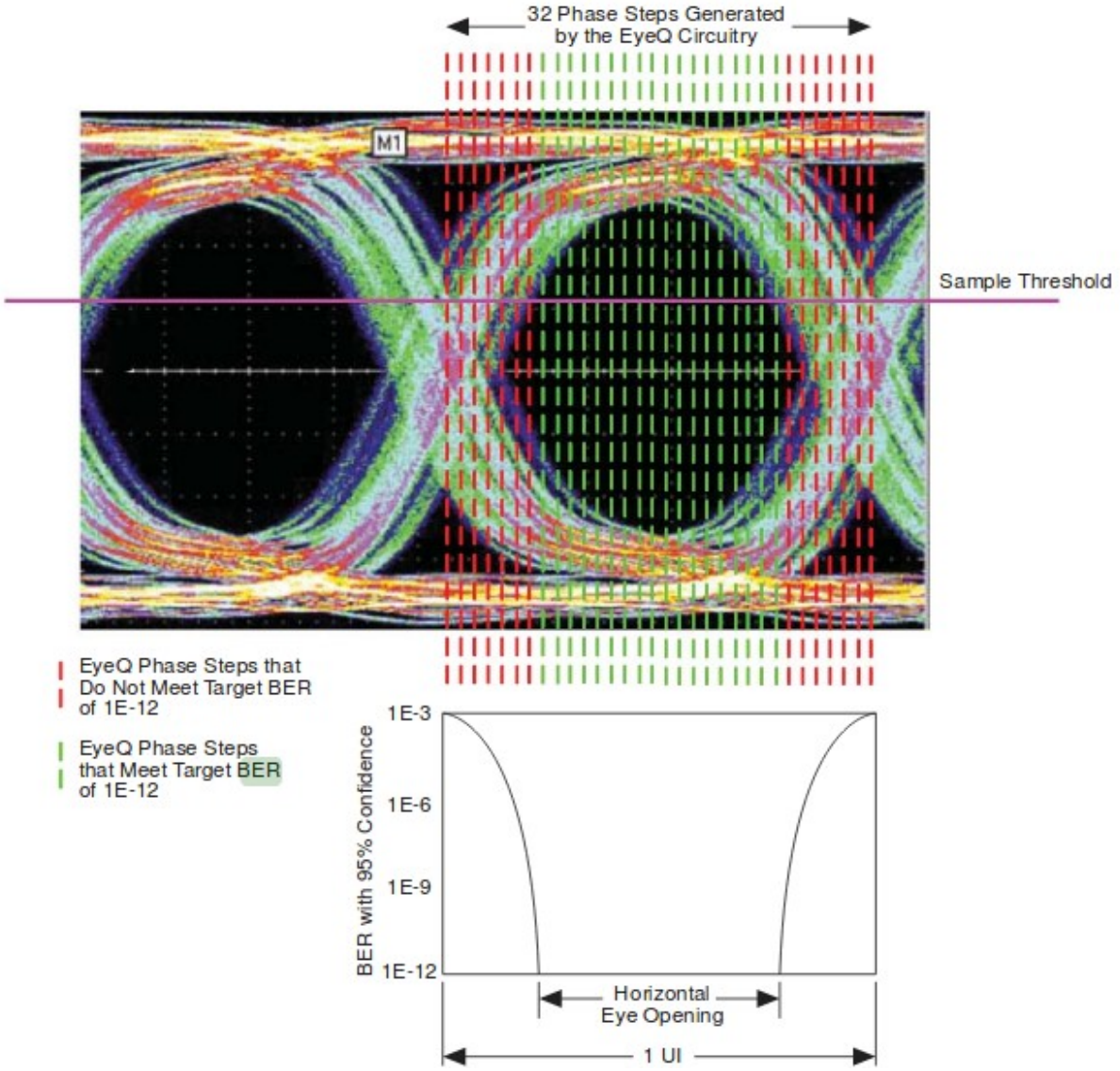
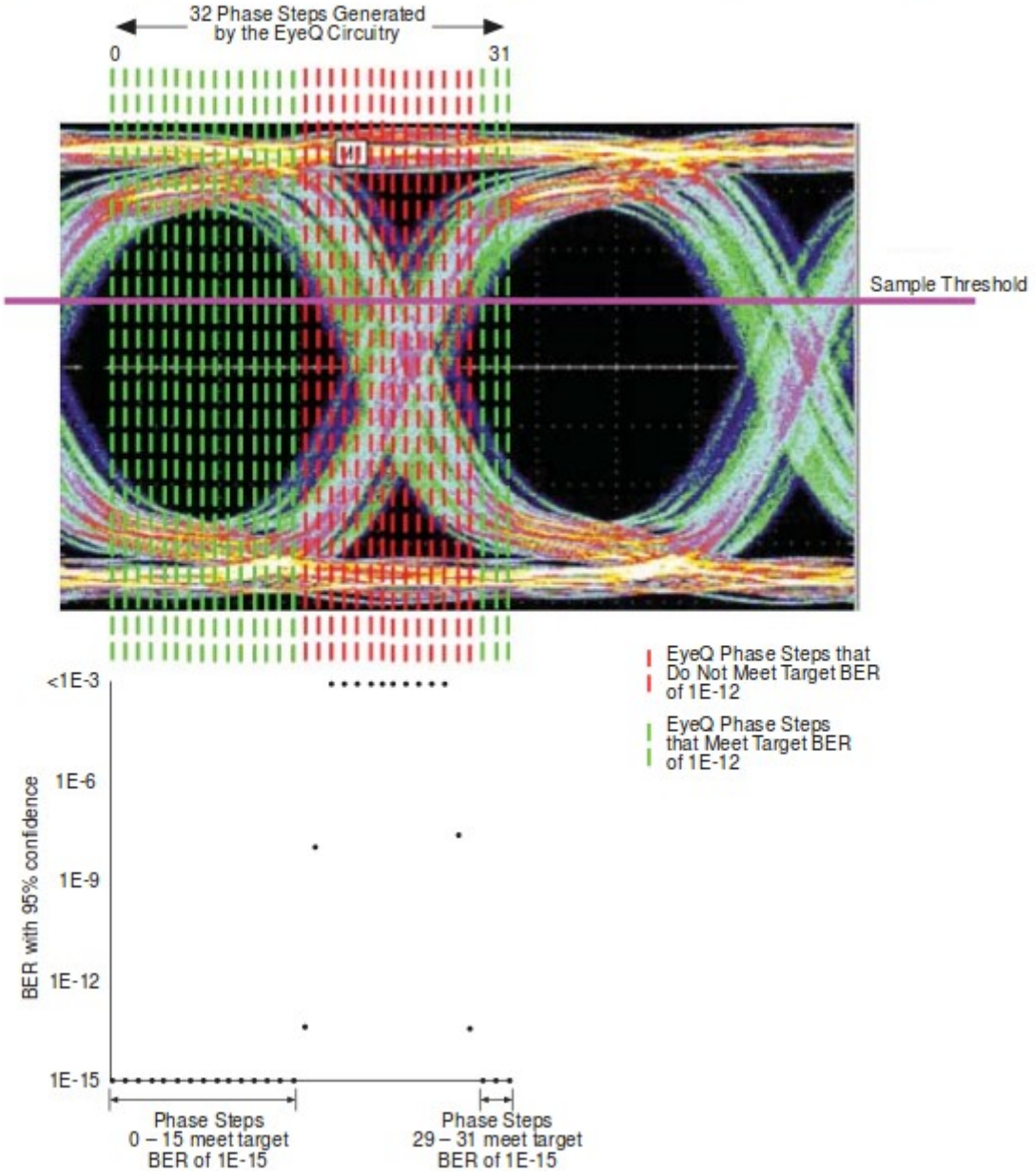


Figure 7. Example of BER Versus EyeQ Phase Step Plot for an RX Equalization Setting of 3



Y esto lo saqué de un ensayo para validar un equipo medidor de BER (BERTScope)
http://application-notes.digchip.com/038/38-21389.pdf
donde se puede ver cómo mejora el BER a medida que se manipula el seteo del pre-énfasis

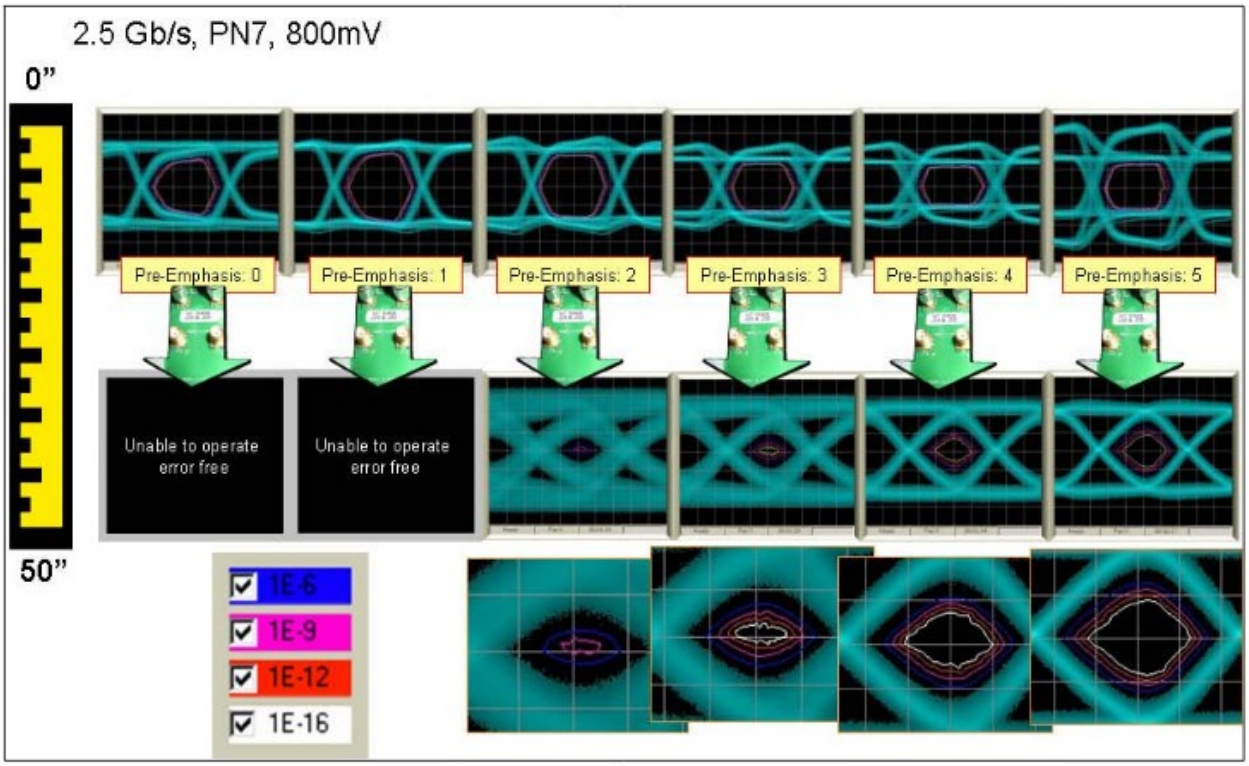


Figure 7: BERTScope BER Contour view of the eye opening.

Con/Sin DFE, aquí encontré estas imágenes comparativas para un ensayo en particular
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.121.6360&rep=rep1&type=pdf

donde se ensayan sistemas sin DFE y con diferentes DFE adaptativos y se analizan las prestaciones en función de diferentes SNR.

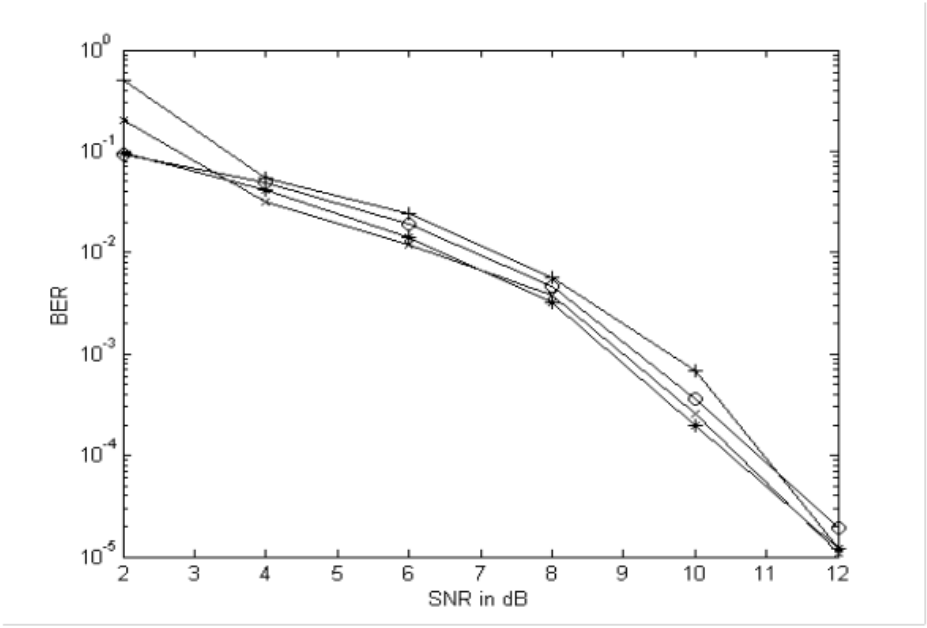


Figure 4.2.2.1. The BER Diagram for Channel Case 1. (x : UDFE, o : Trained DFE, + : DD DFE, *: TRDD DFE)

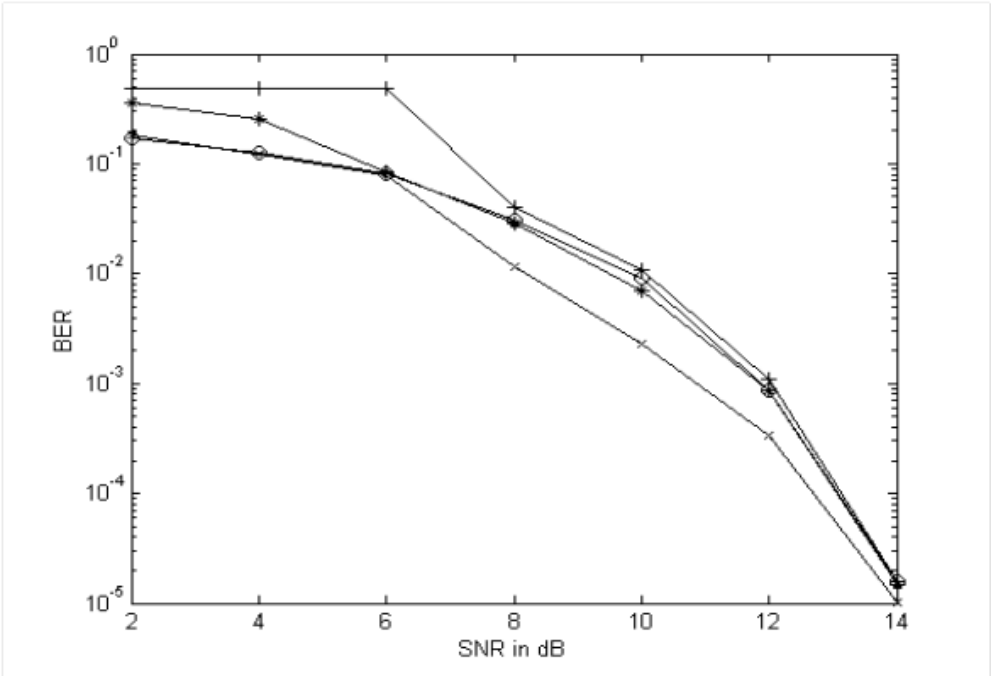


Figure 4.2.2.2. The BER Diagram for Channel Case 2. (x : UDFE, o : Trained DFE, + : DD DFE, *: TRDD DFE)