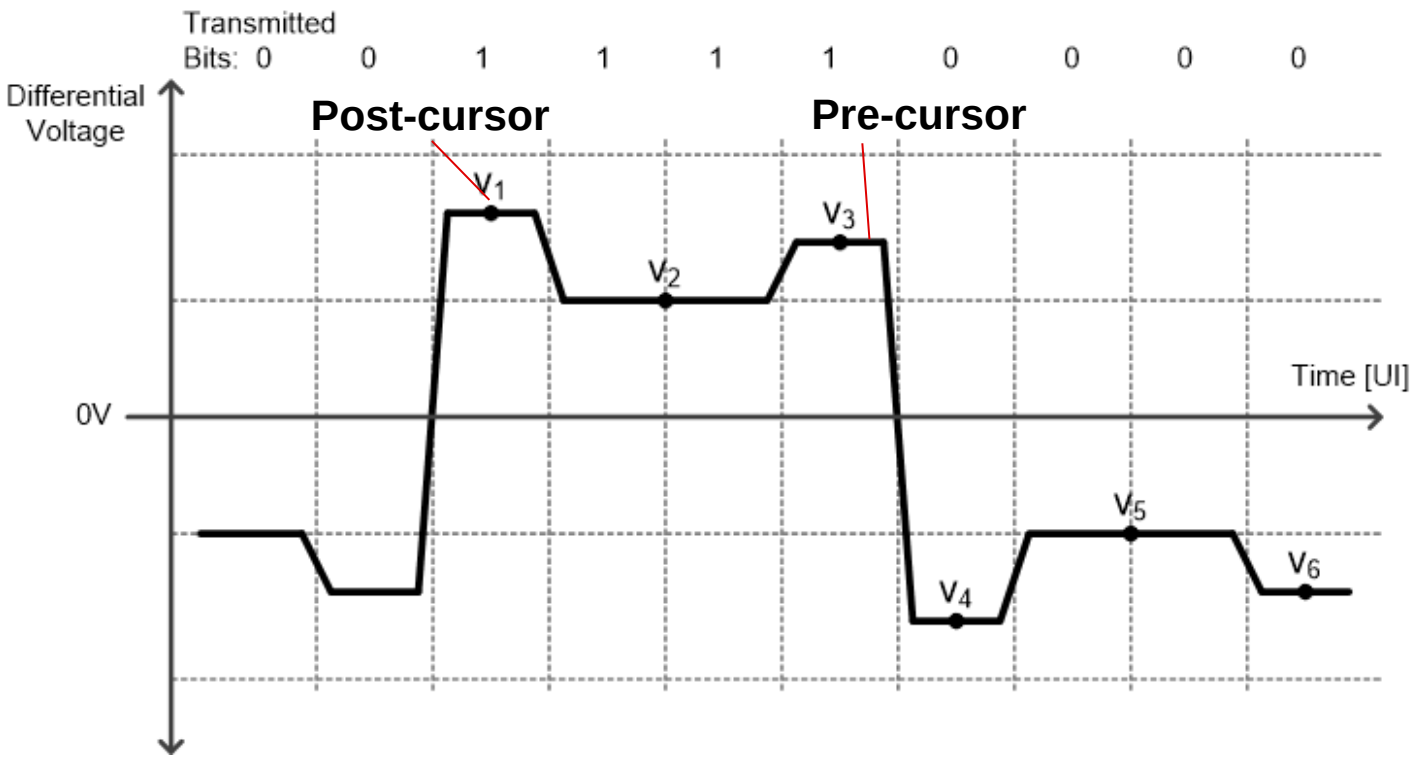
Transmitter Optimization for 25-Gbps Ethernet Data Transmission

TI Precision Labs – Ethernet

Prepared by Rodrigo Natal

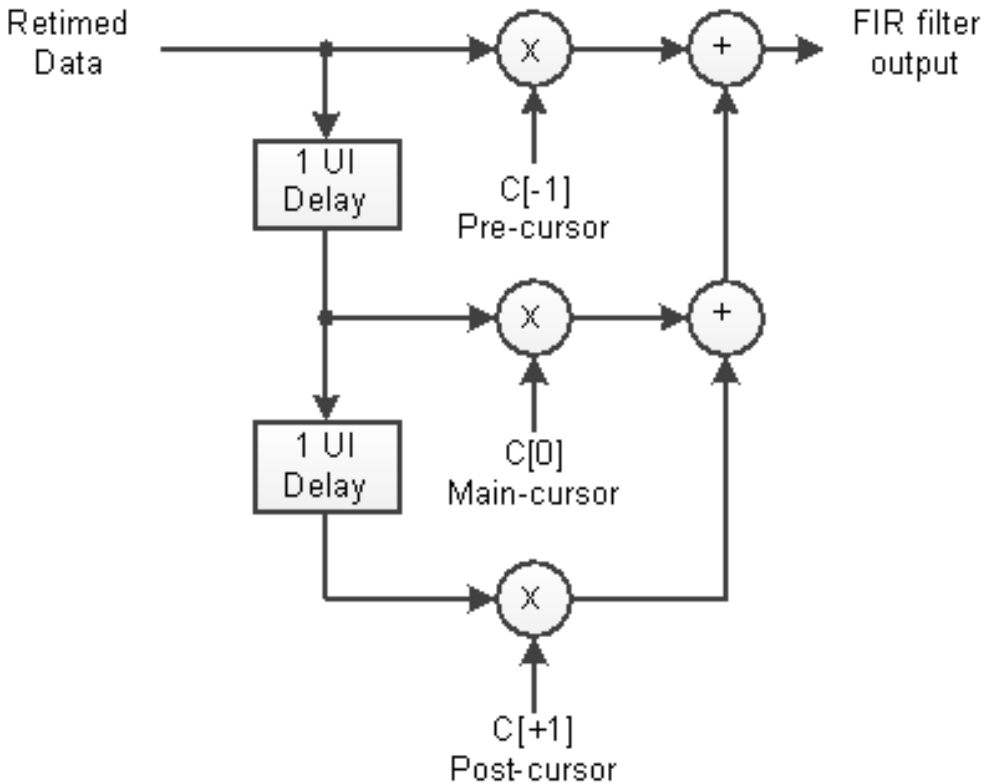
Presented by Nicholaus Malone

25-Gbps retimer Tx output equalization



- ✓ Pre-cursor ratio (in dB) = Rpre = 20 x log10 (v3/v2)
- ✓ Post-cursor ratio (in dB) = Rpst = 20 x log10 (v1/v2)

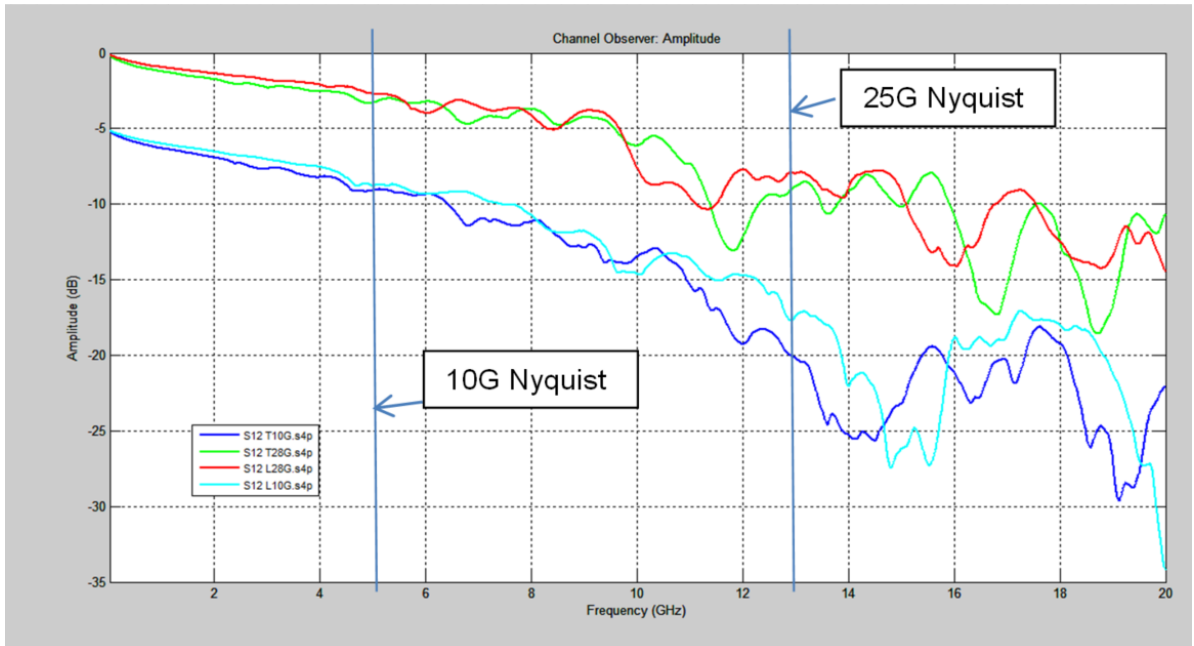
25-Gbps retimer Tx output equalization



FIR block diagram

- Three-tap finite impulse response (FIR) filter, in line with IEEE 802.3
- Allows for both pre-cursor and post-cursor equalization
- Output consists of a weighted sum of three consecutive retimed bits, each affecting the output amplitude
- Used to pre-distort the Tx waveform, to compensate for frequency-dependent loss in the output channel

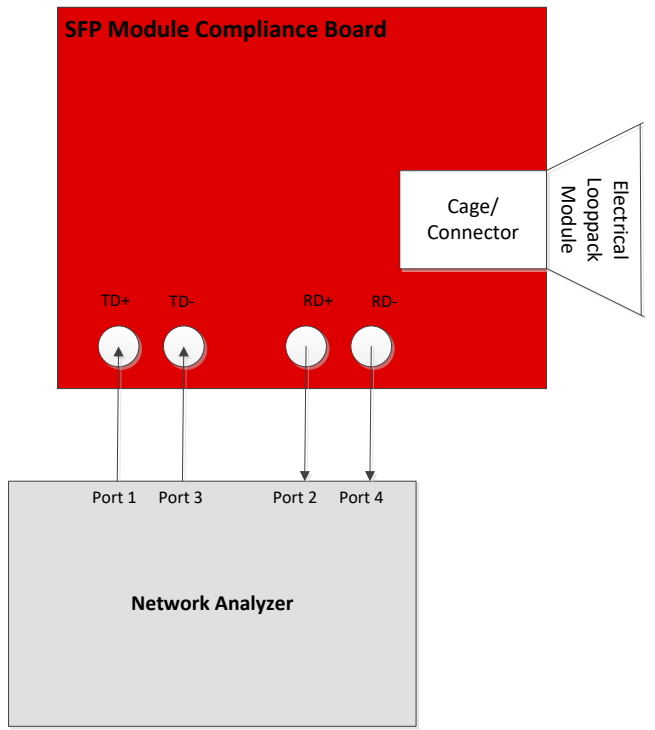
25-Gbps operation requires transmitter optimization



Sdd12 (dB)

Frequency (GHz)

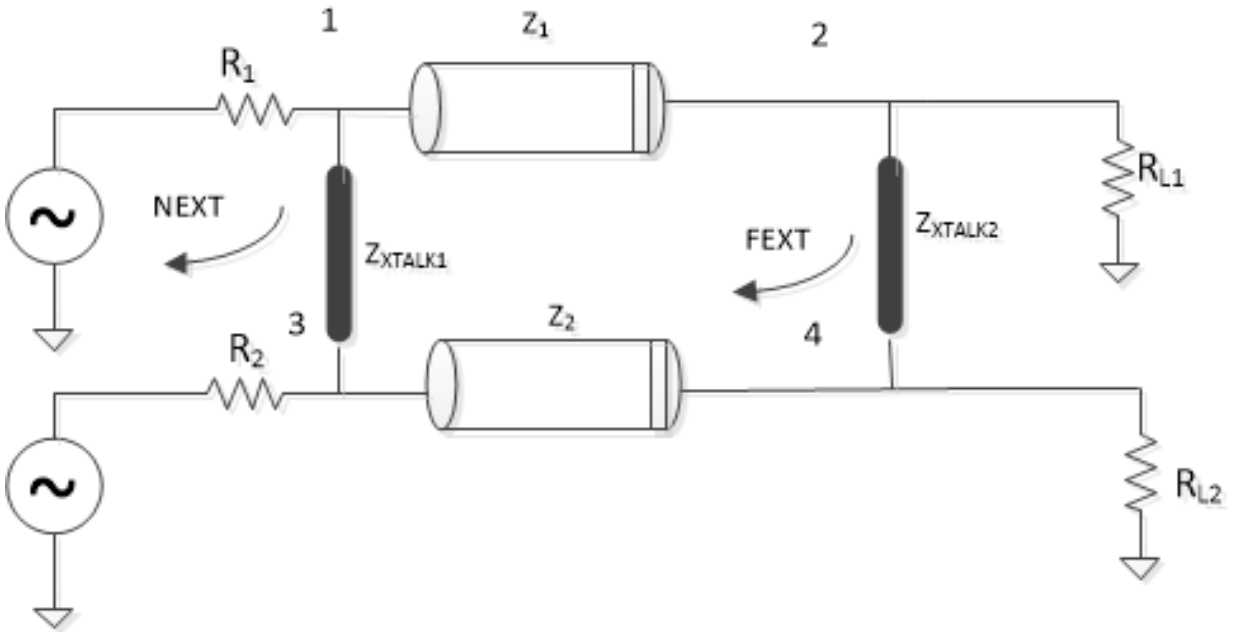
Test setup



- Blue trace: 10G SFP system design top port
- Light blue trace: SFP system design bottom port
- Green trace: 28G SFP system design top port
- Red trace: 28G SFP system design bottom port

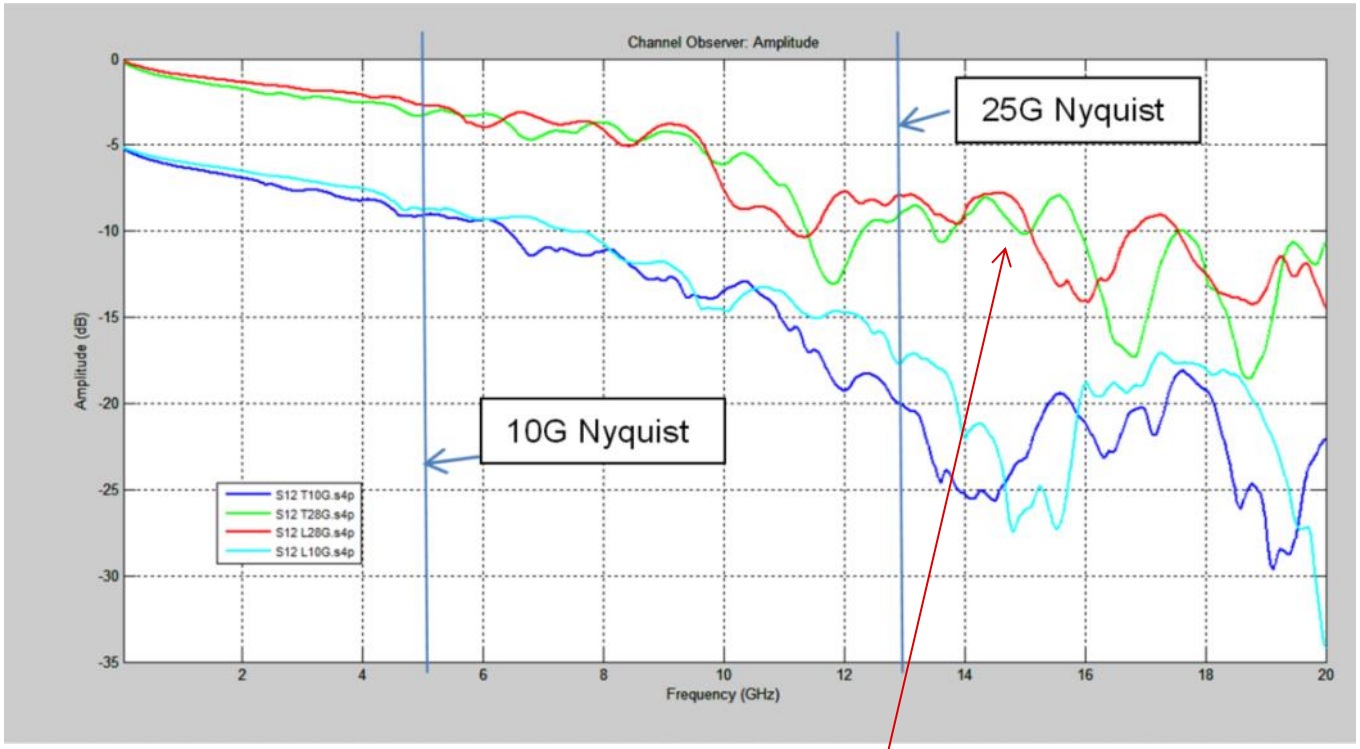
SFP -> Small-form factor pluggable
https://en.wikipedia.org/wiki/Small_form-factor_pluggable_transceiver

Major impairments: reflection and cross talk



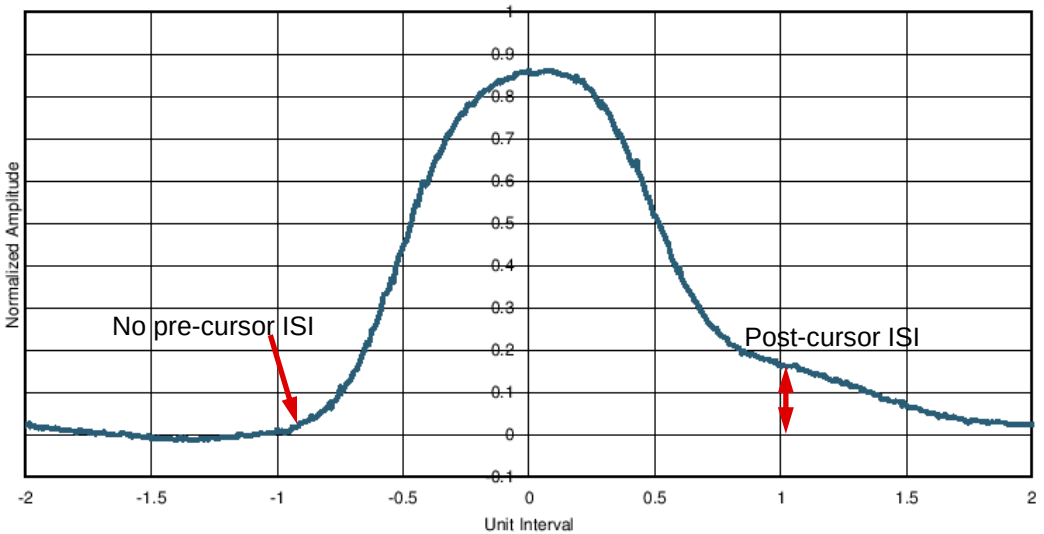
- PCB channels behave less ideally at higher frequency, due to parasitic effects
- Parasitics (inductive or capacitive) lead to:
  - Impedance mismatch ($Z \neq R_L$)
  - Coupling between adjacent data channels (crosstalk impedance parameters Z_{XTALK1} and Z_{XTALK2})
- These effects result in signal reflections and crosstalk

Major impairments: reflection and cross talk

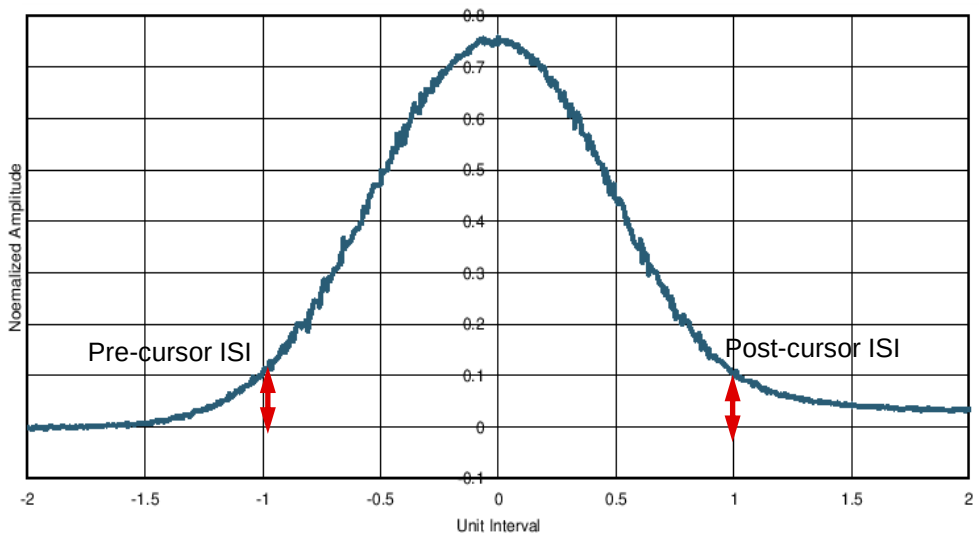


- Impedance mismatch appears as ripple on insertion loss plot
- Ripple is greater at ~12.5GHz and above

More pre-cursor dispersion at 25G versus 10G



Normalized pulse response for 10-Gbps rate -8 dB channel loss

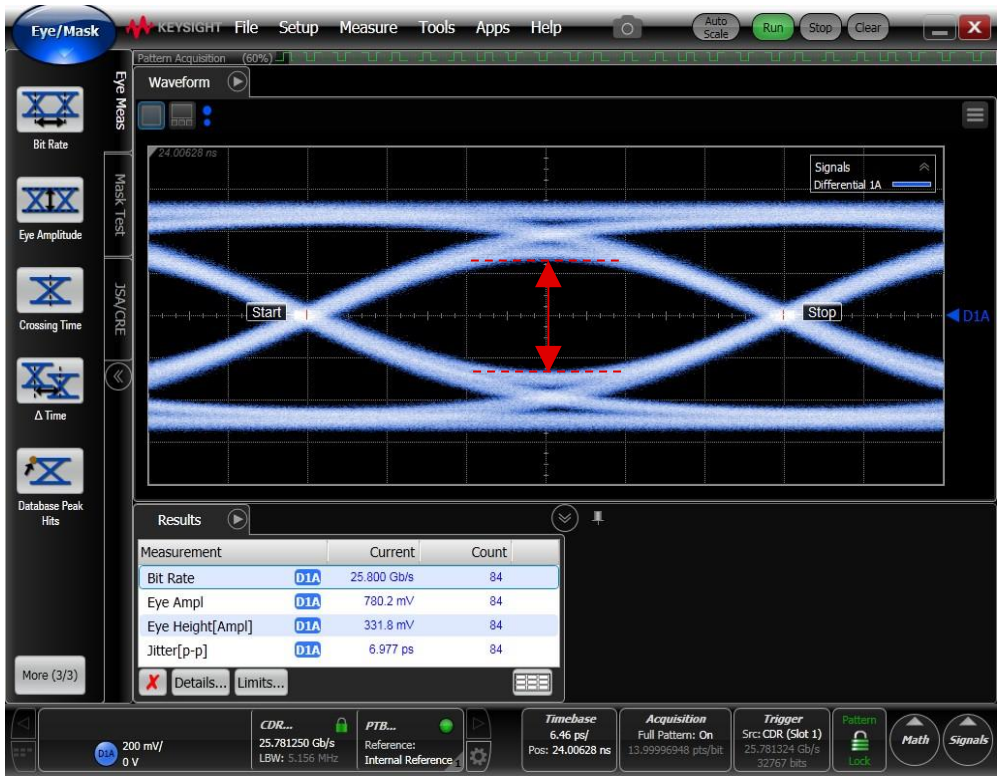


Normalized pulse response for 25-Gbps rate -8 dB channel loss

- Post-cursor inter-symbol interference (ISI) equates to the transmission channel's insertion loss
- Pre-cursor ISI is a second order dispersion effect not from loss. It is typically near zero for most 10-Gbps PCB channels
- Pre-cursor ISI is significant for 25-Gbps applications and must be compensated for in most 25-Gbps links to ensure adequate bit error rate margin

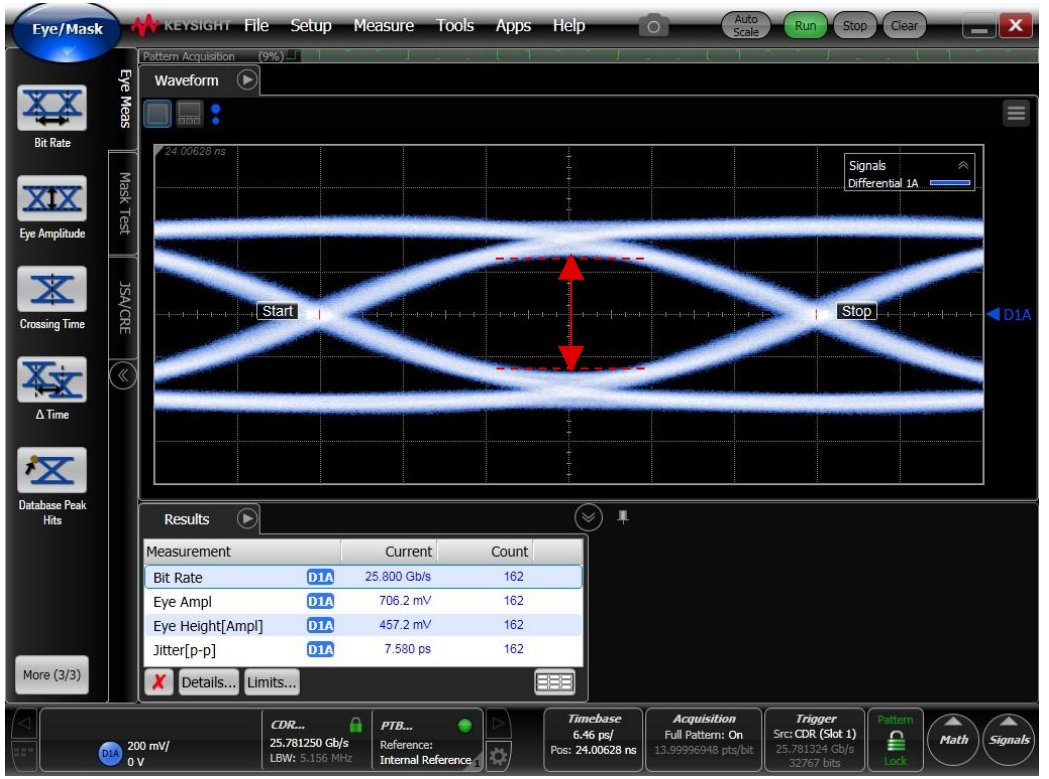
Eye diagrams comparison after ~6-dB loss media

No FIR pre- or post-applied



Eye height = 331.8 mV

FIR pre- and post-applied



Eye height = 457.2mV

Short quiz

- Which FIR tap best helps to compensate for insertion loss?
  - Pre-cursor
  - Post-cursor
  - Both
- Pre-cursor dispersion is higher at lower data rates
  - True
  - False
- Which signal impairment(s) is usually worse at 25Gbps than 10Gbps for a given channel?
  - Insertion loss
  - Crosstalk
  - Reflections
  - All of the above