How does signal integrity affect eye diagrams?

TI Precision Labs - Signal Conditioning

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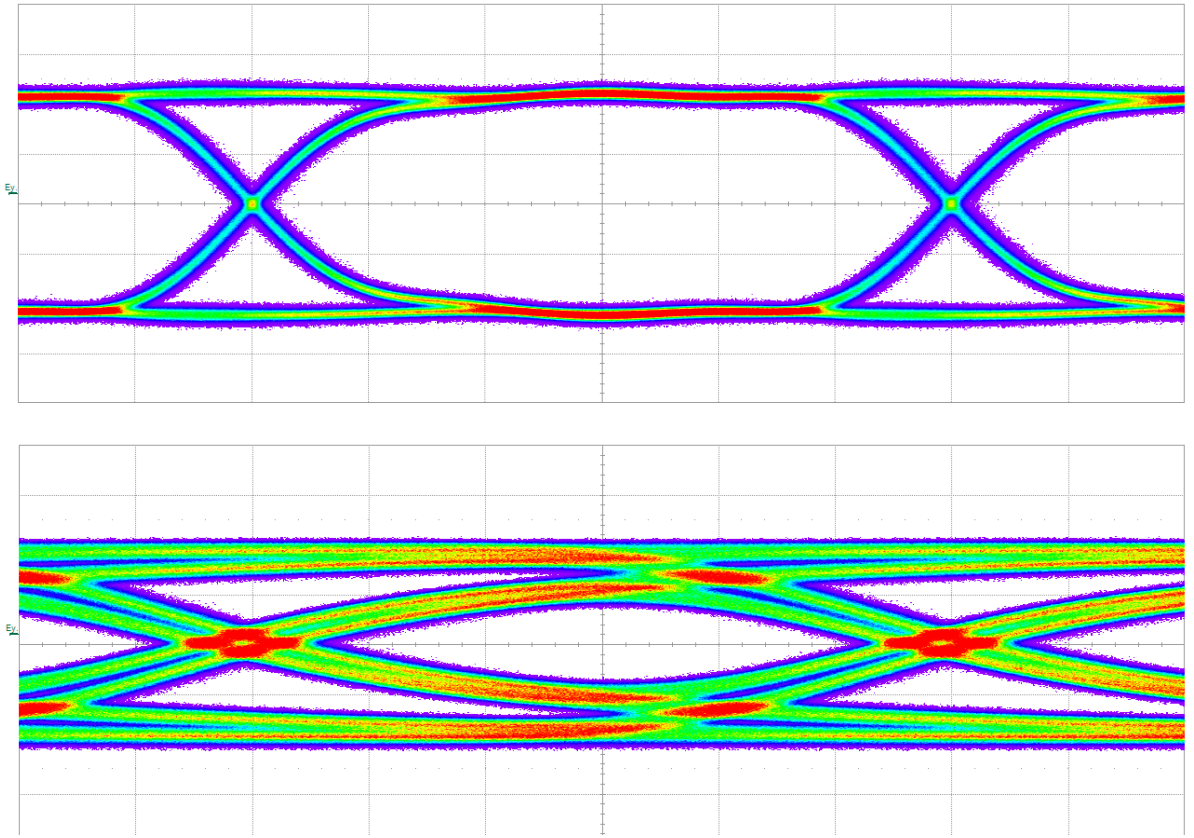
Texas Instruments

Why is signal integrity important?

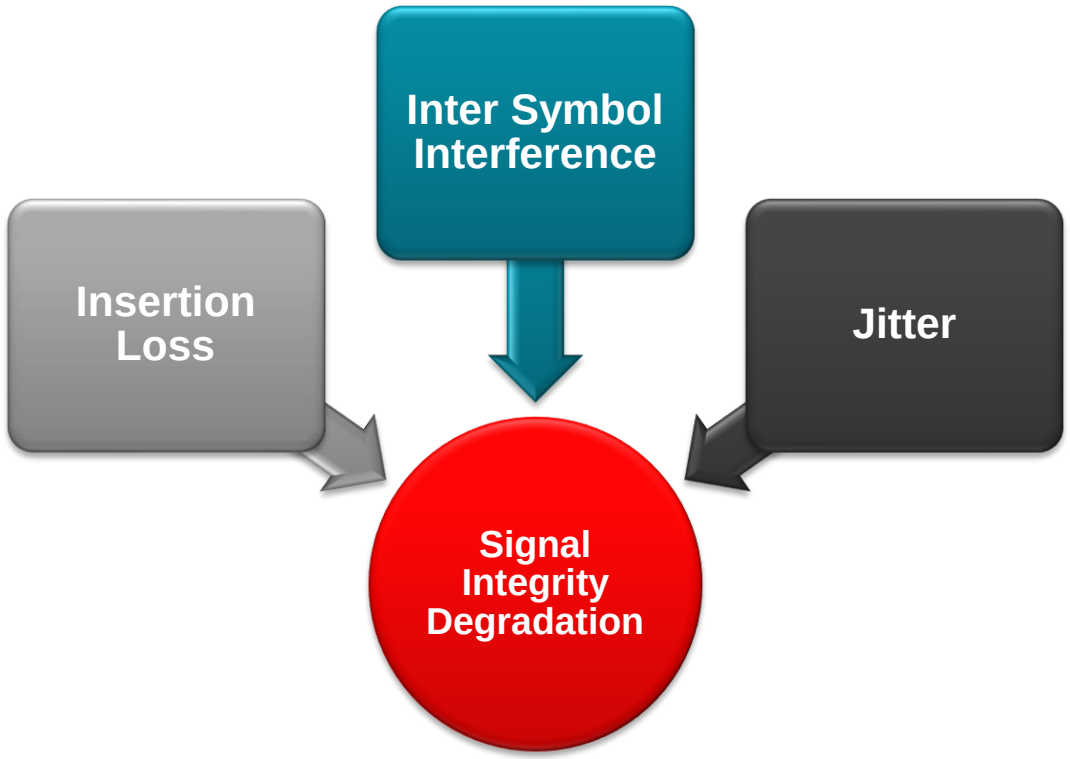


Eye diagrams help to determine if transmitted data can be correctly interpreted by far end data receiver.

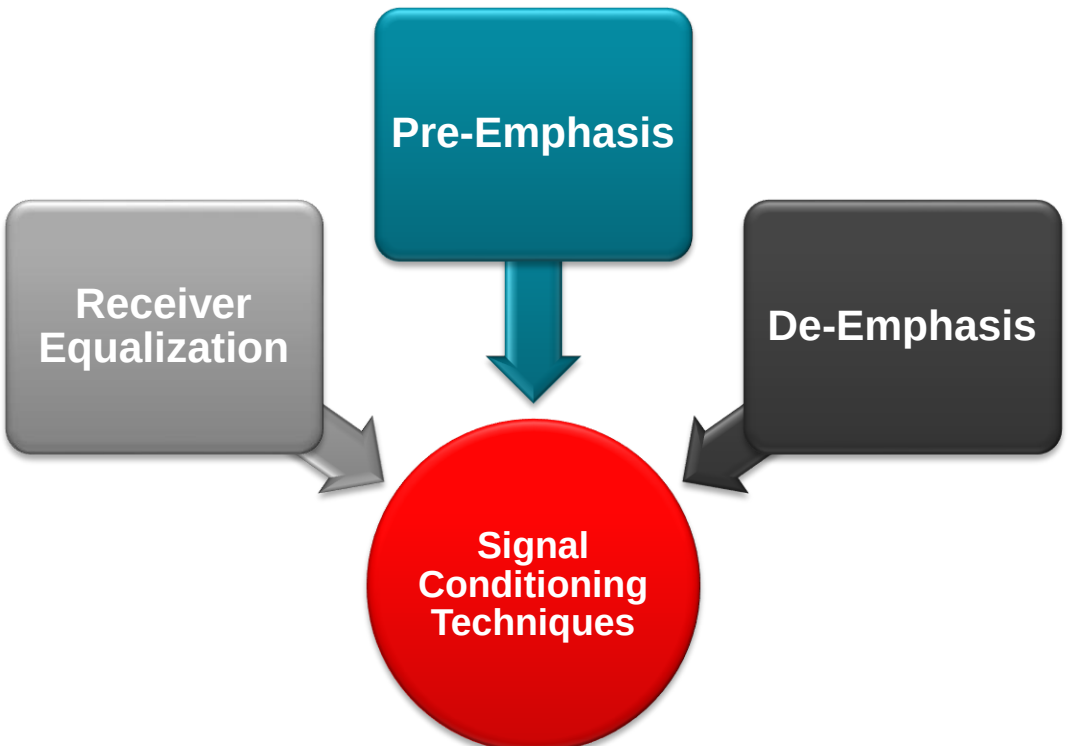
- If signal integrity is poor, eye diagrams can violate per-defined limits specified by the eye mask.
- A poor eye diagram can cause the receiver to not recover the data, then link drops out or data stream is corrupted.

High-speed signal integrity challenges

The higher the data rate your design requires, the more prone it is to signal integrity degradation.

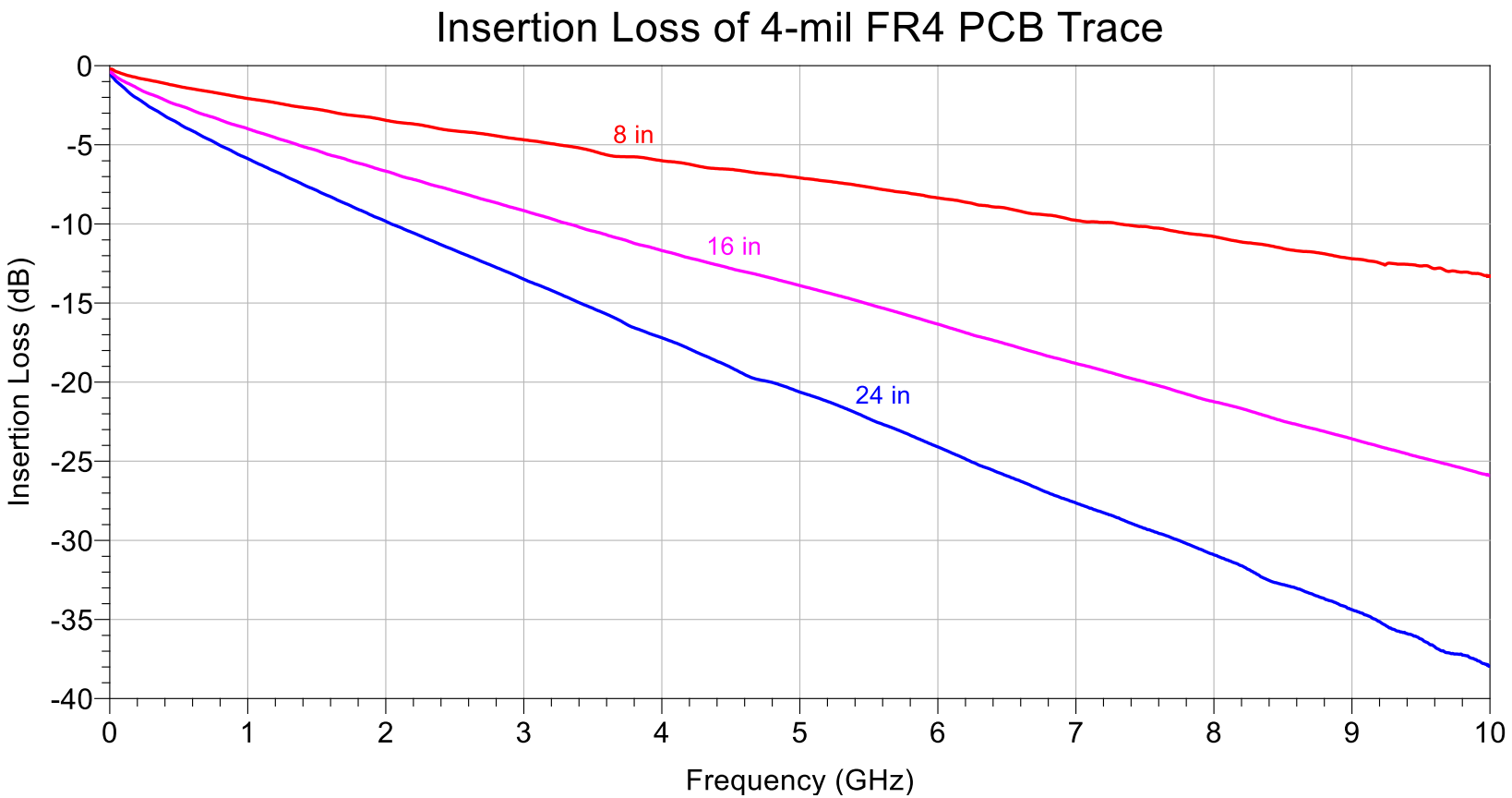


High-speed signal integrity solutions



What is insertion loss?

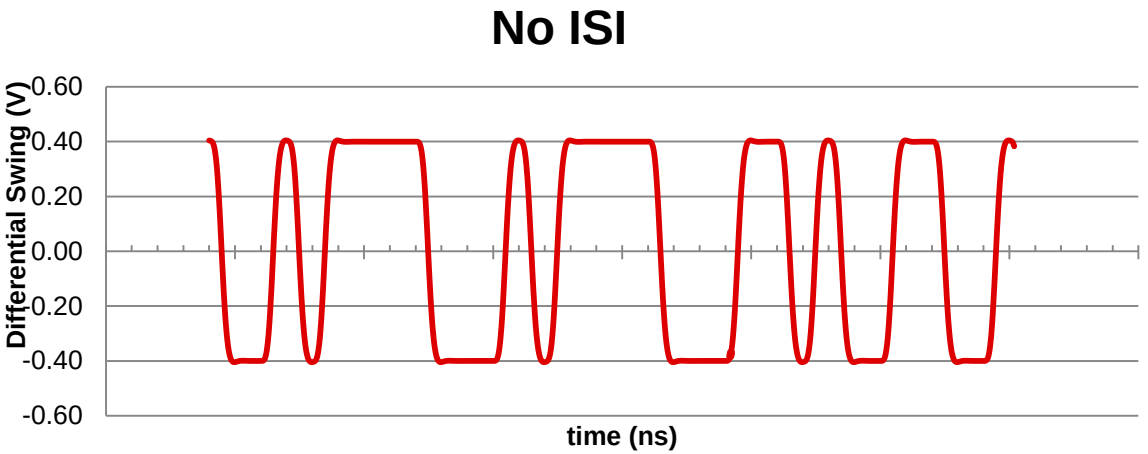
A frequency dependent loss of signal power that is dependent on channel length and material properties.

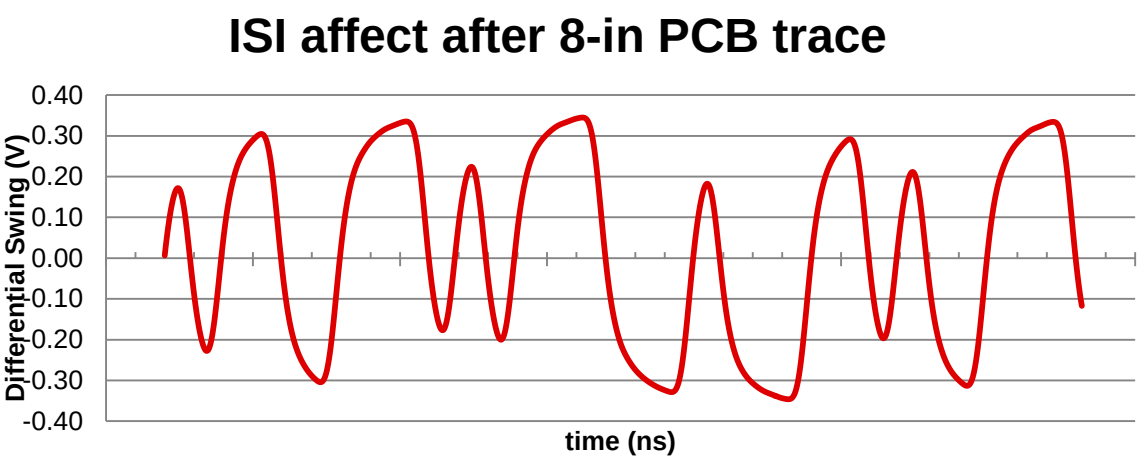


What is inter-symbol Interference (ISI)?

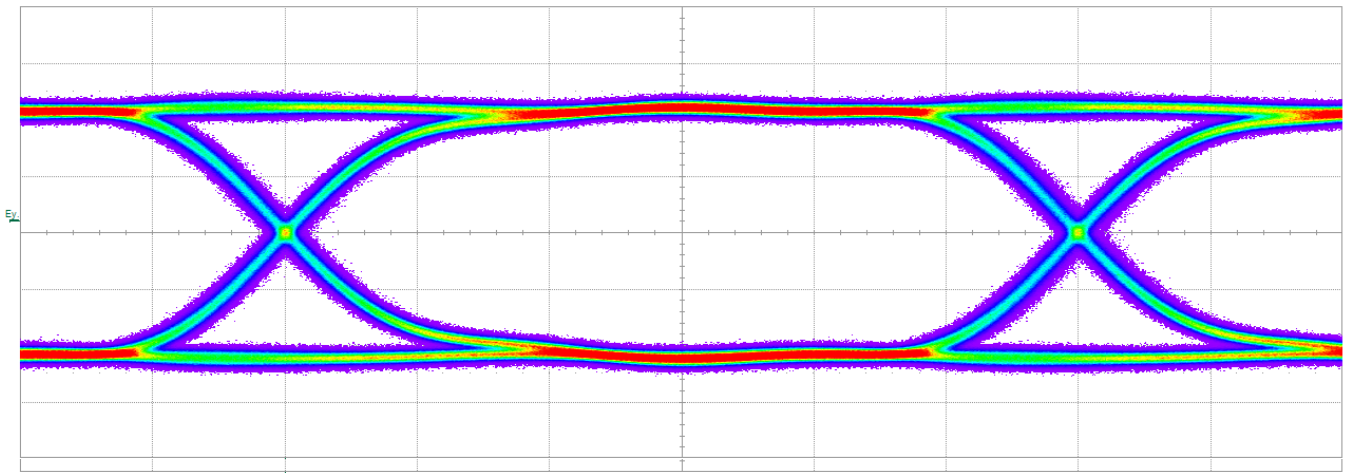
Inter symbol interference (ISI) is the destructive interaction of distorted “symbols” in the data stream.

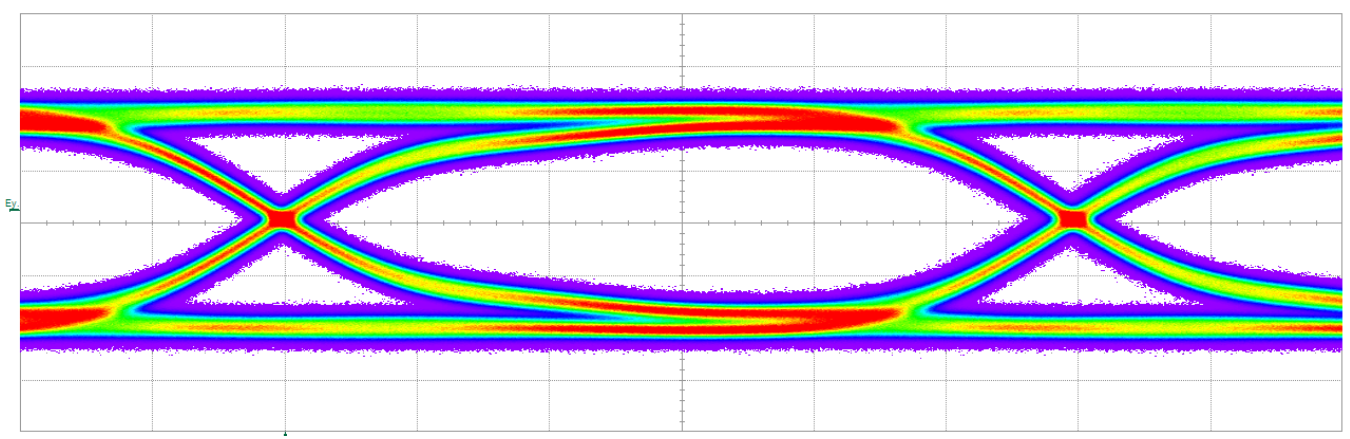
Variations in the insertion loss profile cause ISI.





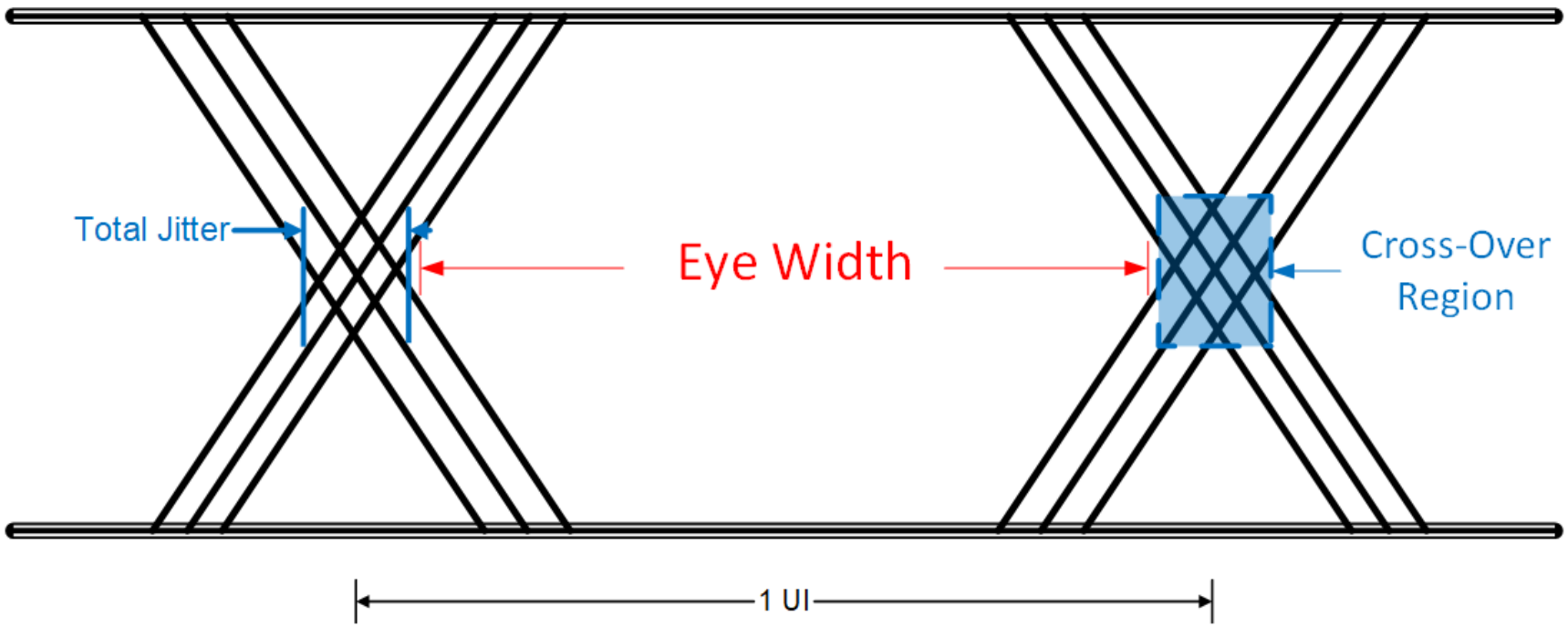
How do insertion loss & ISI affect the eye diagram?



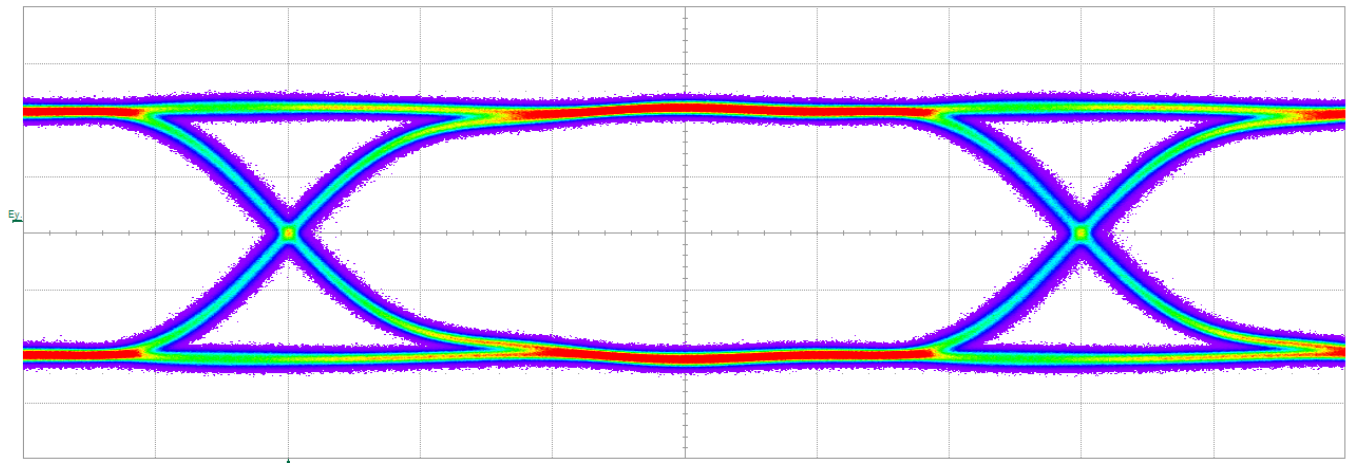


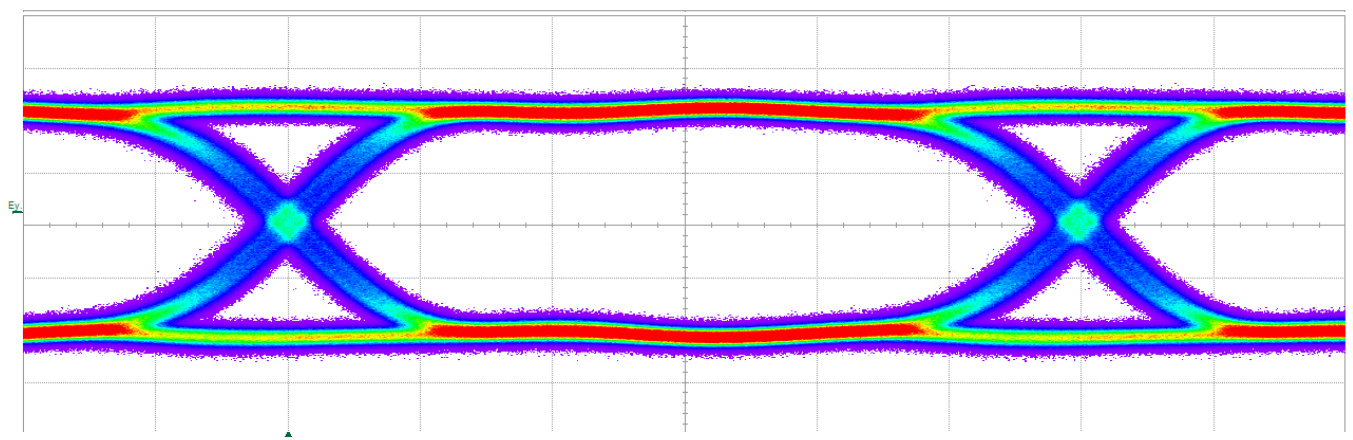
What is jitter?

Any deviation from true periodicity of a digital signal. Signal attenuation typically manifests as data-dependent jitter.



How does increased total jitter affect the eye diagram?

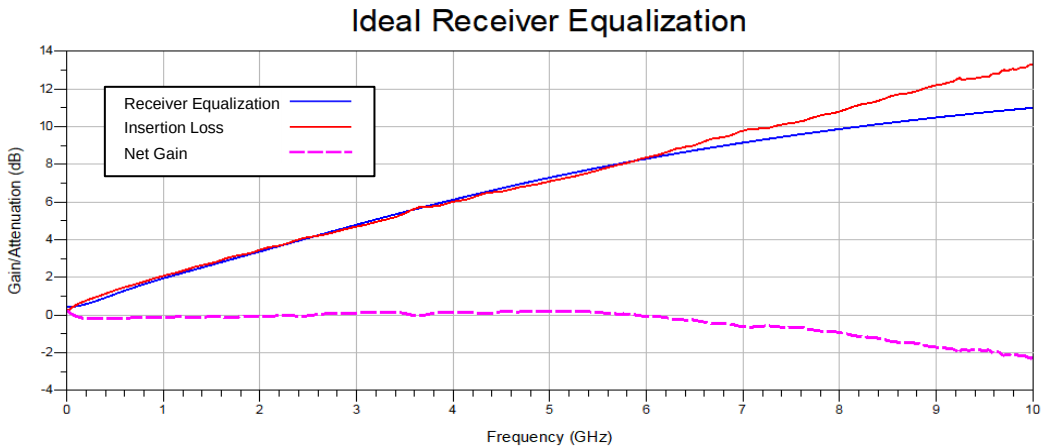


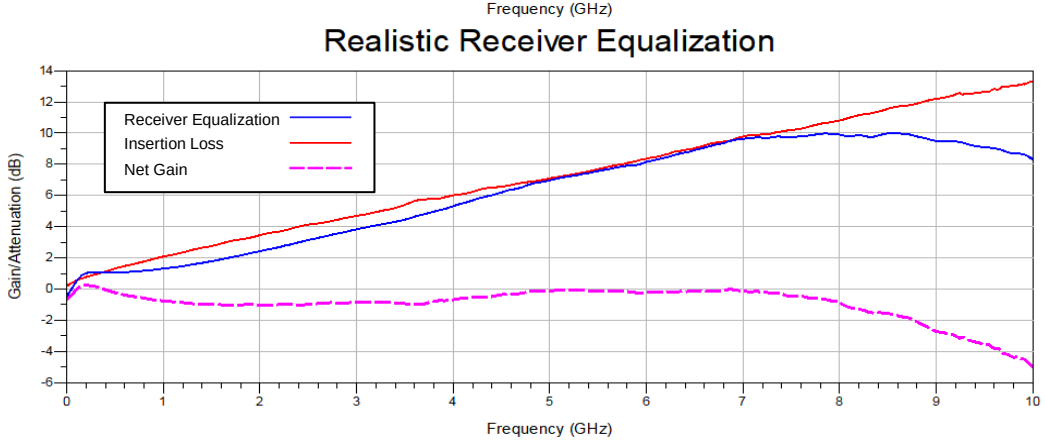


What is receiver equalization?

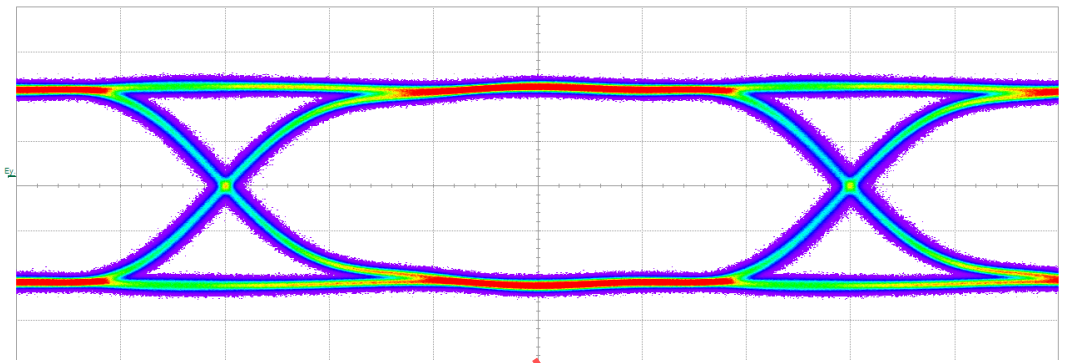
Equalization is applied at the receiver

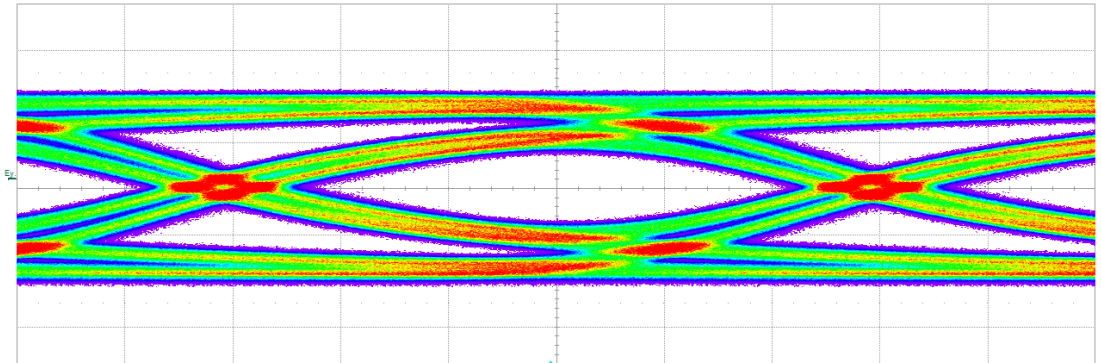
- Selectively boosts high-frequency data
- Compensates for the large attenuation of transmission media at high frequency.
- Often “programmable” or “adaptive” for added flexibility

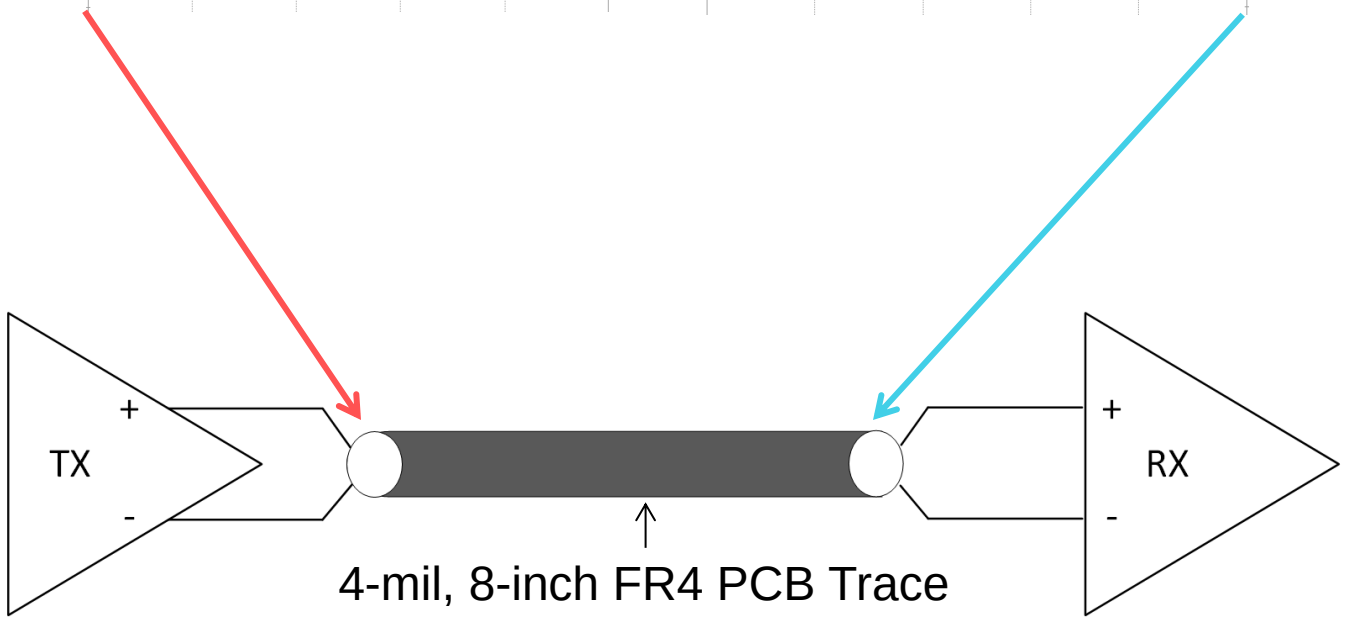




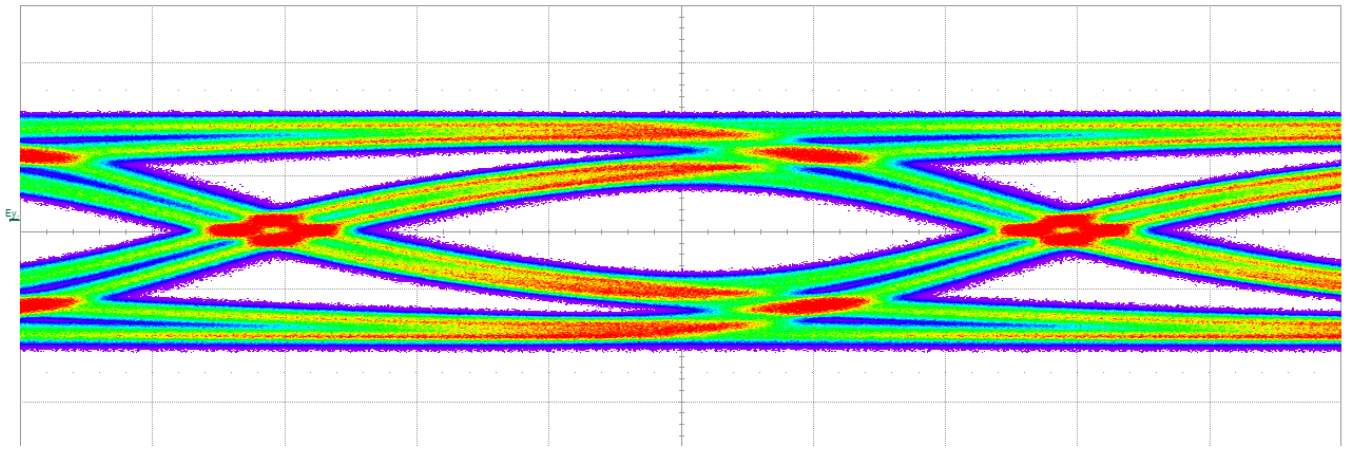
Why is receiver equalization important?

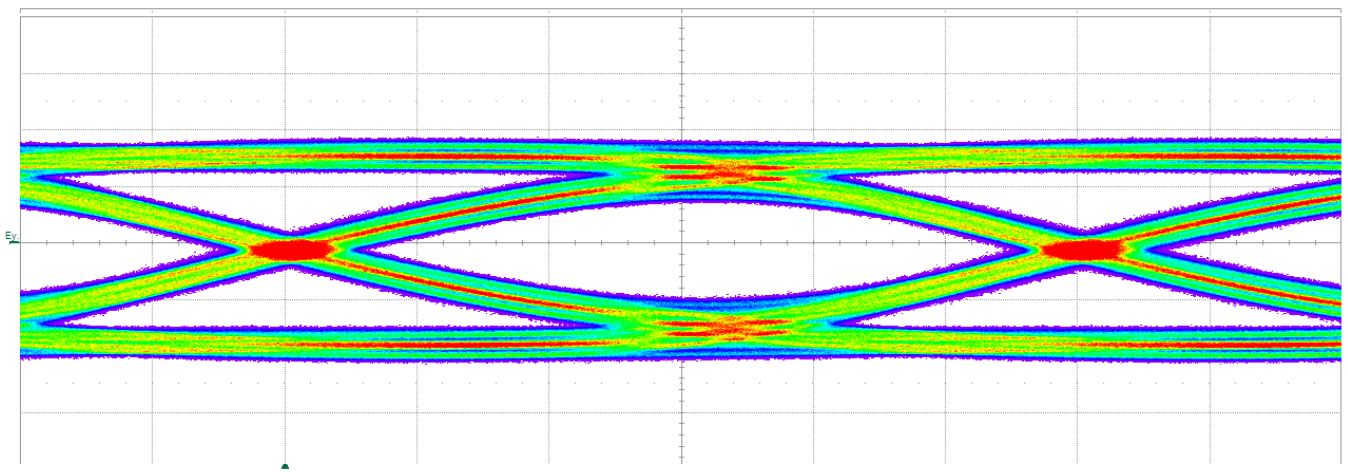






How does receiver equalization affect the eye diagram?

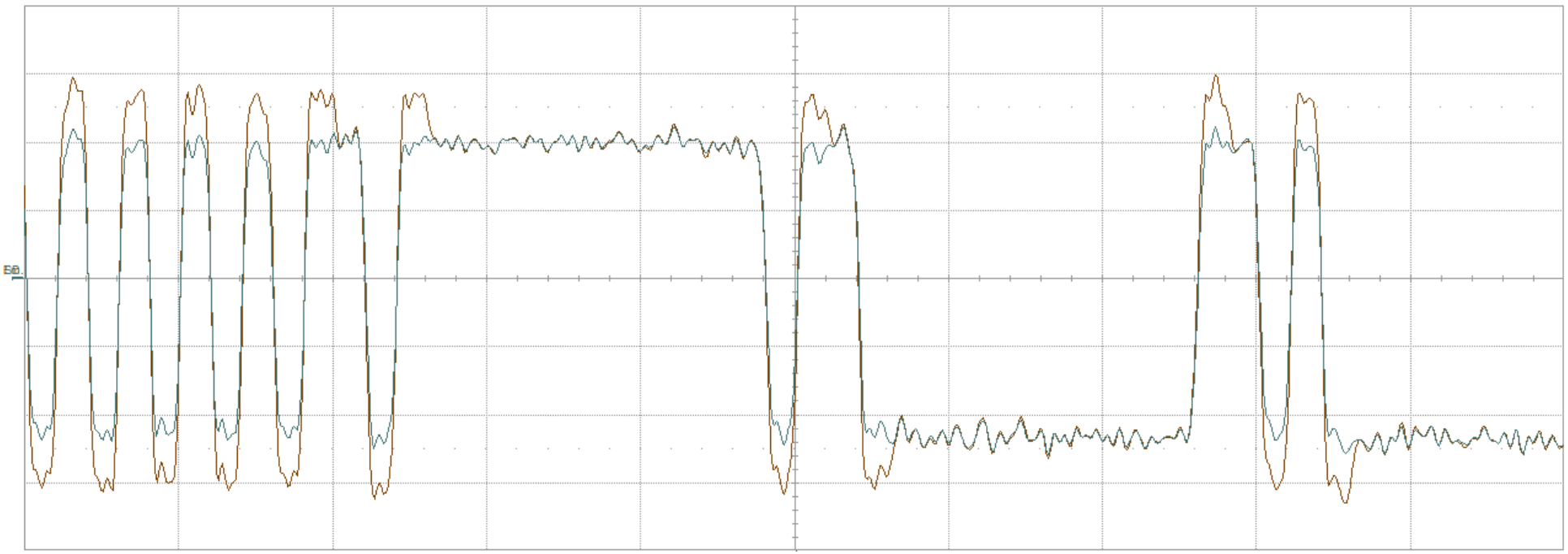




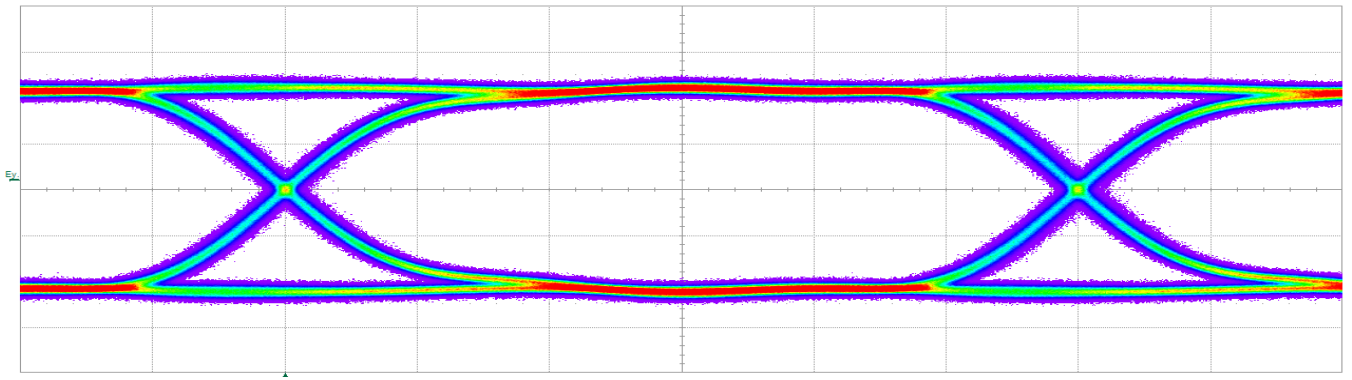
What is pre-emphasis?

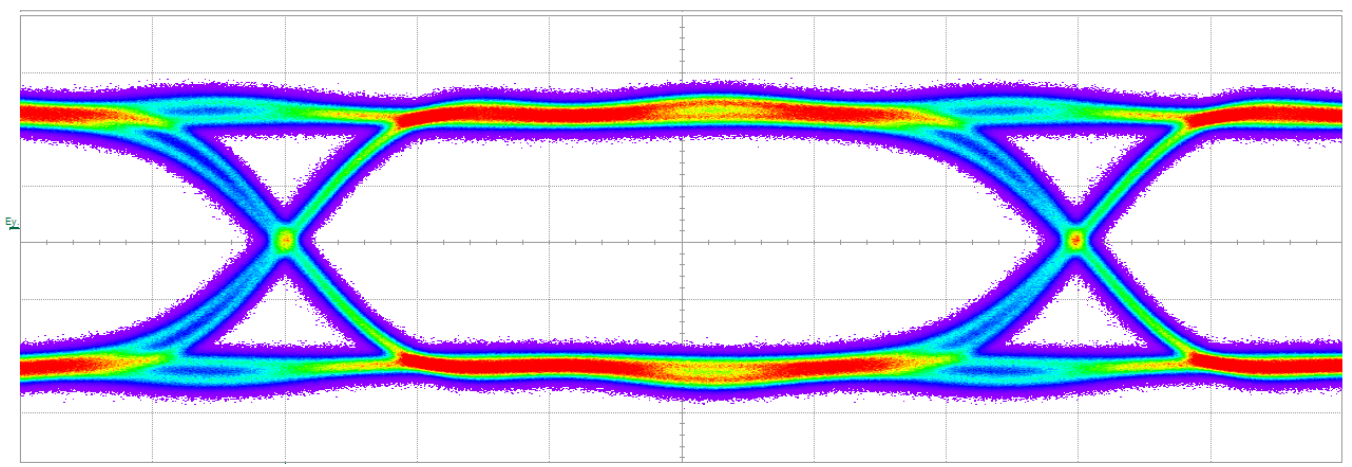
Address high frequency media loss by applying a frequency-selective boosting to edges at the transmit end of the signal path.

High frequency component is boosted by creating an overshoot on every edge in data stream.



How does pre-emphasis affect the eye diagram?

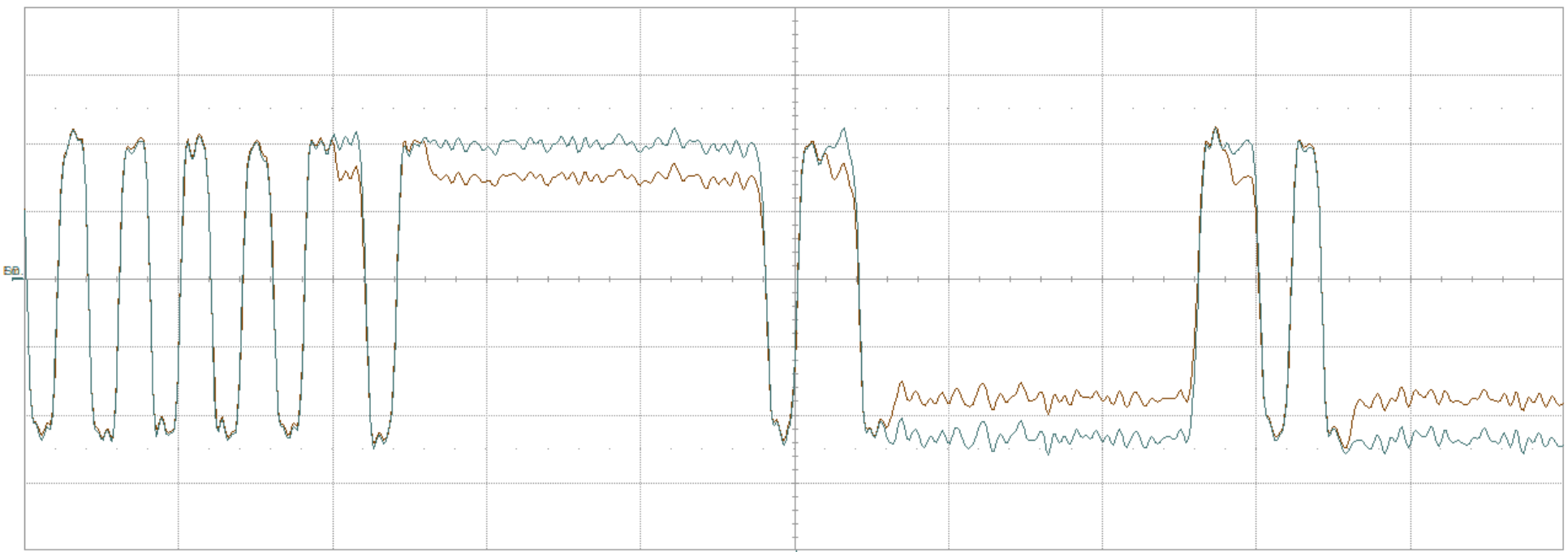




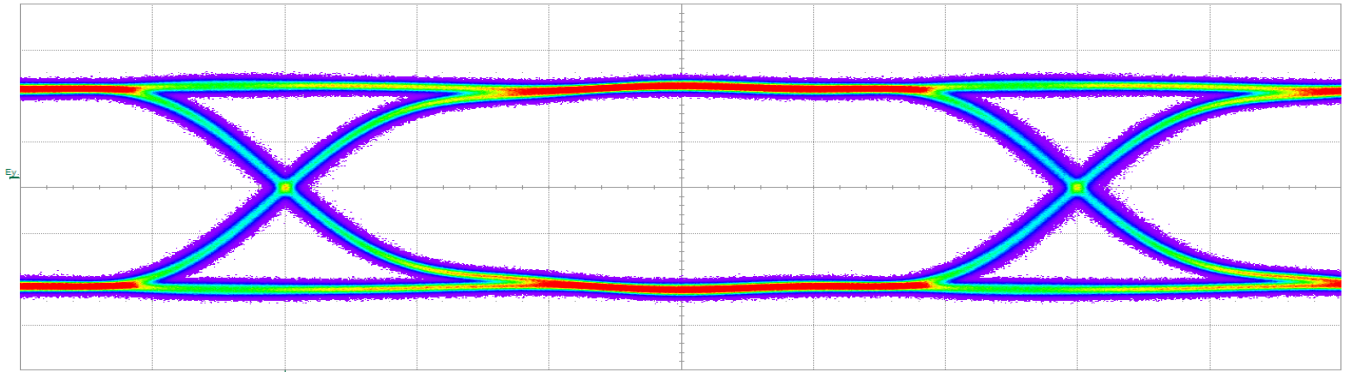
What is de-emphasis?

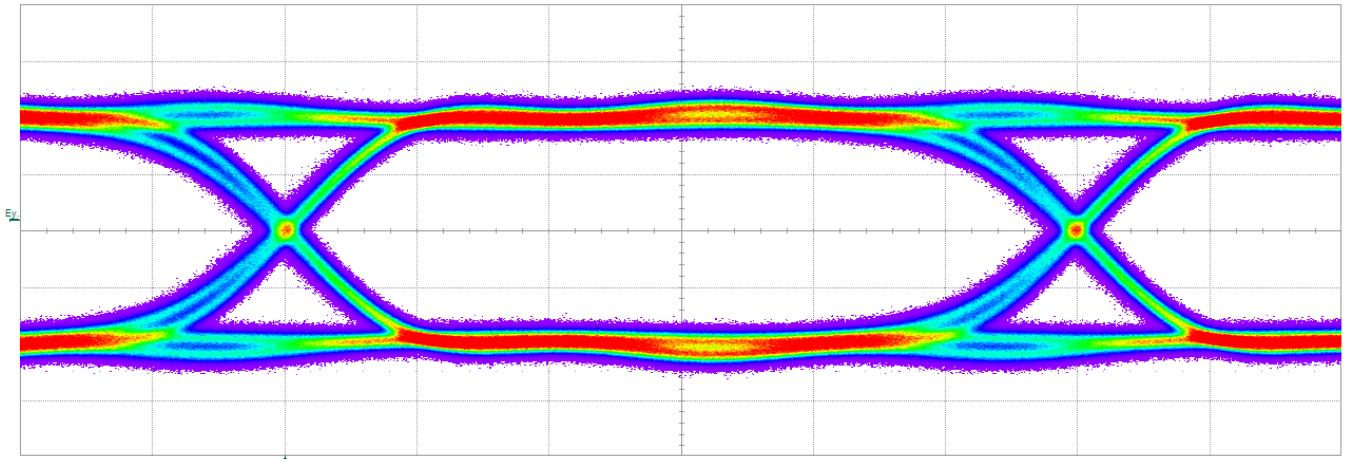
Address high frequency media loss by applying a frequency-selective boost or attenuation component to the data at the transmit or receive end.

Lower frequency components are attenuated to make edge more prominent.



How does de-emphasis affect the eye diagram?





Short quiz

- Check all correct statements:
  A. Pre-emphasis impacts the high frequency content of a signal.
  B. Receiver equalization helps to attenuate signals in a fixed frequency band.
  C. Pre-emphasis and De-emphasis are only applied at the transmitter.
  D. De-emphasis impact the low frequency content of a signal.
- Check all correct statements:
  A. Insertion loss is present in all transmission media.
  B. Increased total jitter shrinks the measured eye width.
  C. ISI will impact all “symbols” in the data stream in the same way.
- True or False:
  A. Signal conditioning techniques are important tools to help ensure a good eye diagram.

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