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Introspect Technology & Trust-Tek Corporation

Practical Experiences in MIPI D-PHY℠ and C-PHY℠ Receiver Testing

2017
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HSINCHU CITY, TAIWAN
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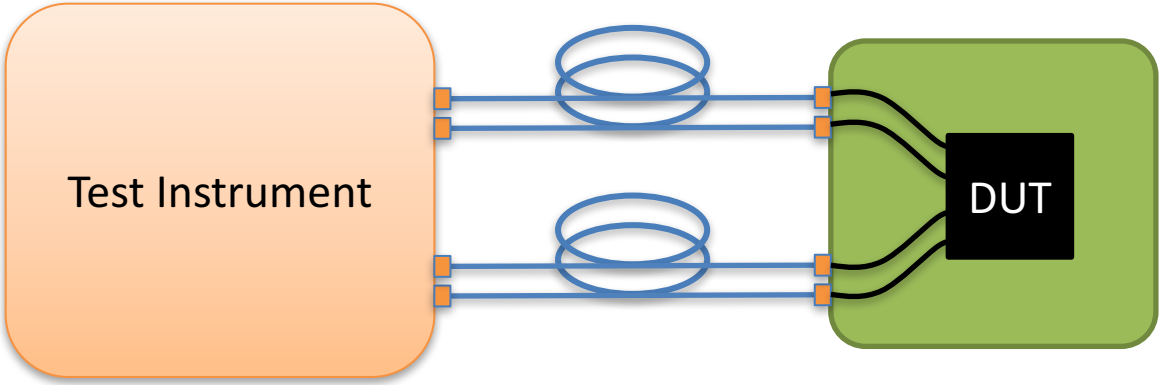
In Theory…



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In Real Life…

Test Requirements Through Product Lifecycle Stages

IP Bring-Up

- Test IP in isolation
- Theoretical case (perhaps!)

Component Bring-Up

- Focus on entire chip functionality including interface
- Other effects start to appear

Application Module Bring-Up

- Where is the receiver?
- Where is the channel?
- What stimulus to use?

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Agenda

- Overview of receiver test
- Illustration of practical module implementations and evaluation platforms
- Recommendations and best practices

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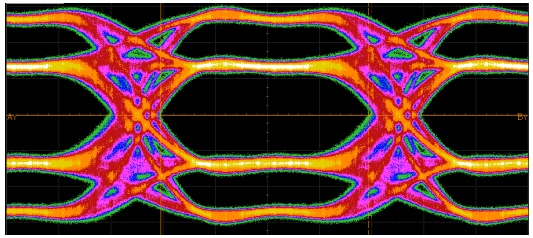
Physics of Signal Transmission

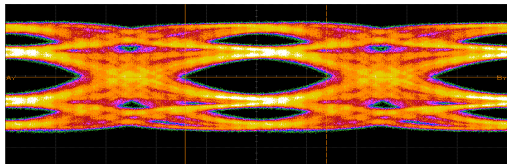
Transmitter



Large Signal
Small Noise

Receiver

Small Signal
Large Noise



Channel (cable, connector, flex PCB, package)

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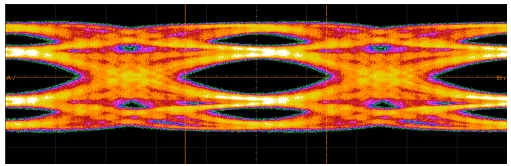
Objective of Receiver Test

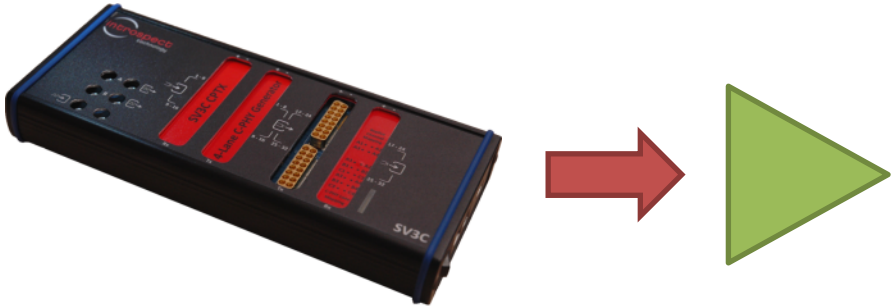
Generate a stressed signal as if it went through a channel

- Model ISI
- Model DCD
- Model Jitter

Receiver

Small Signal
Large Noise





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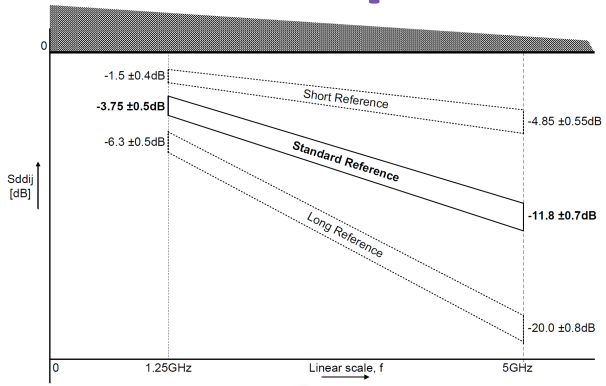
MIPI D-PHY^{SM} Receiver Specification



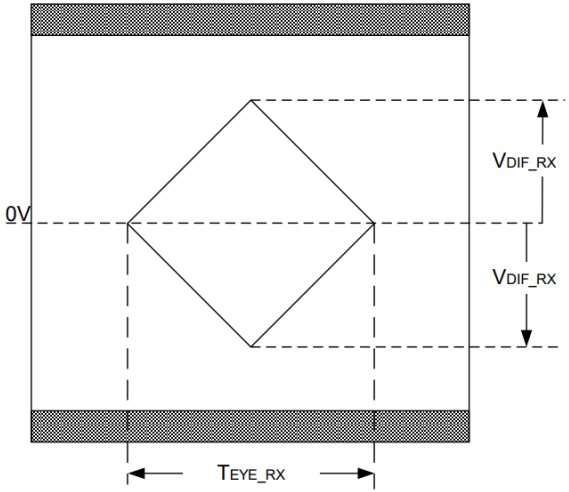
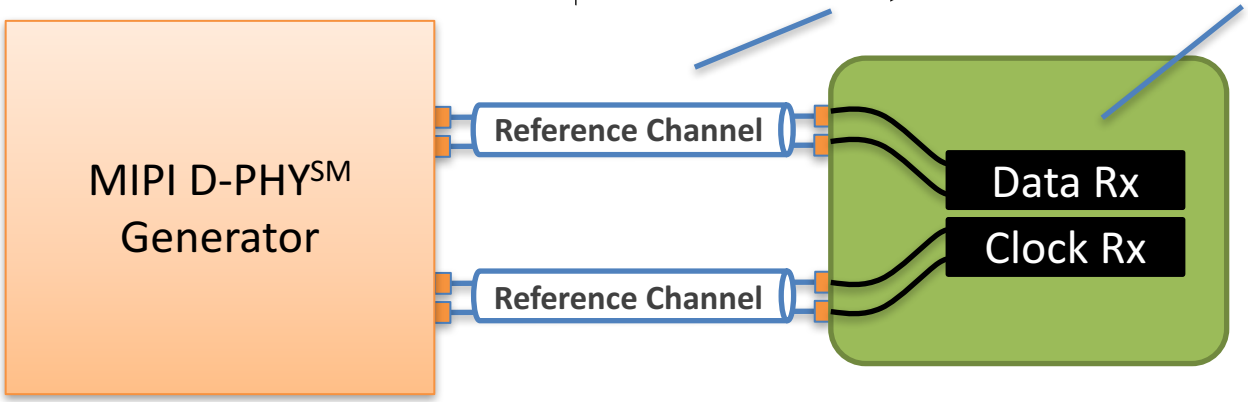


Figure 67 Receiver Eye Diagram Specification



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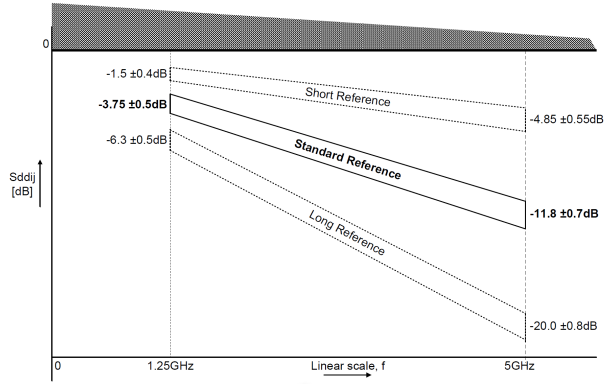
MIPI C-PHY^{SM} Receiver Specification



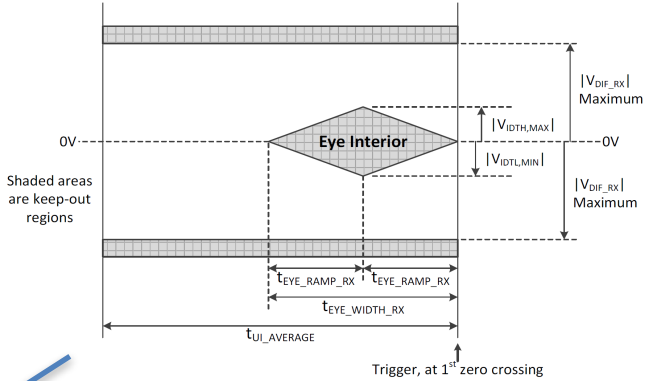
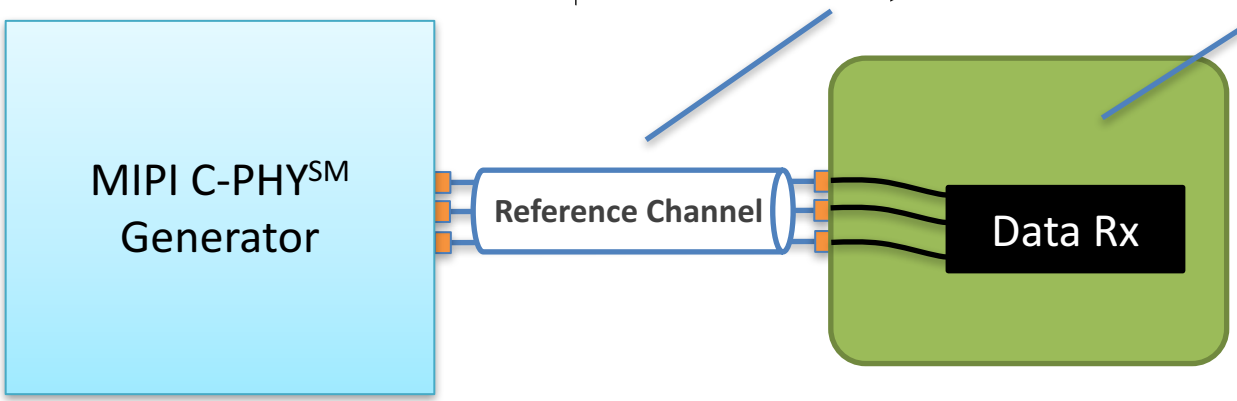


Figure 81 C-PHY Receiver Eye Diagram



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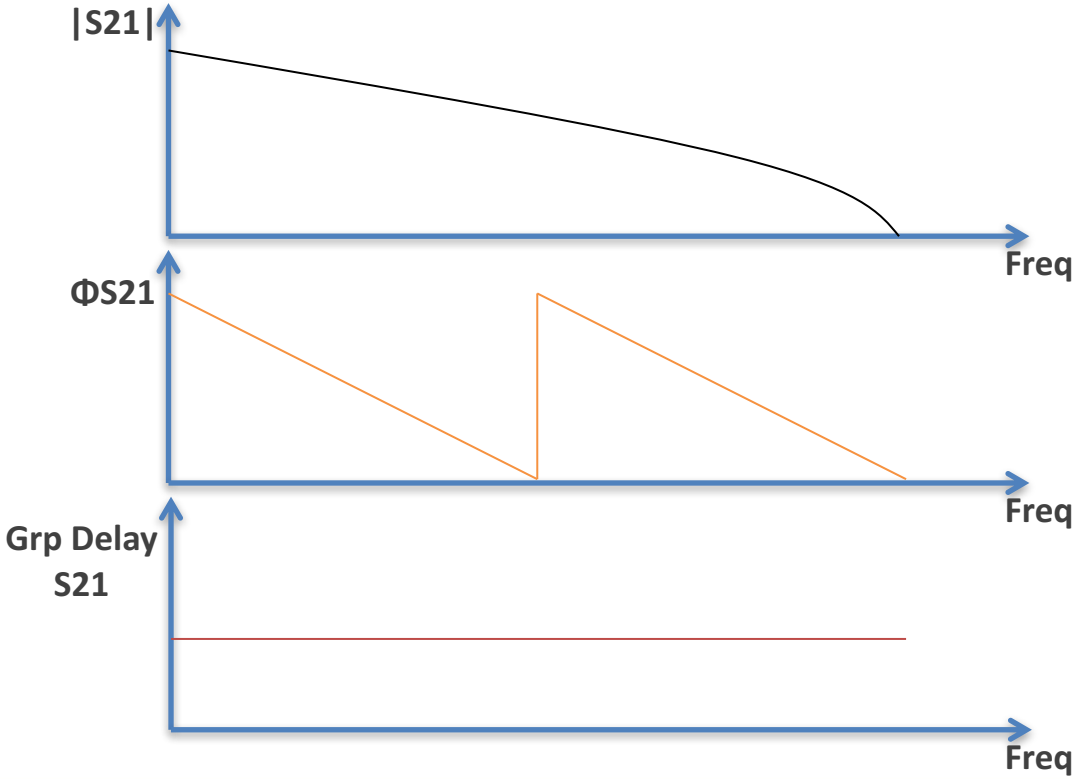
The Linear Channel Model



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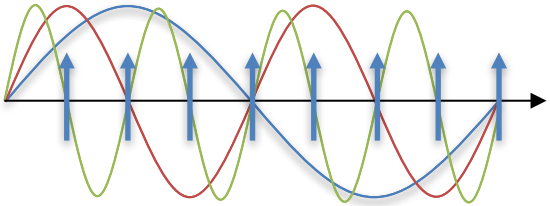
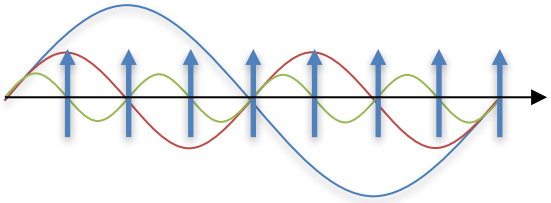
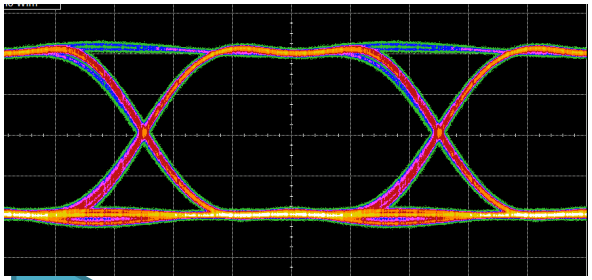
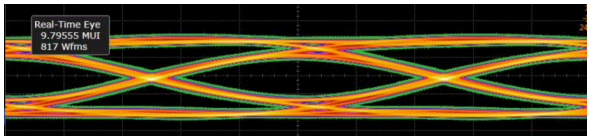


Timing Edges Largely Unaffected in a Linear Channel







Linear Channel

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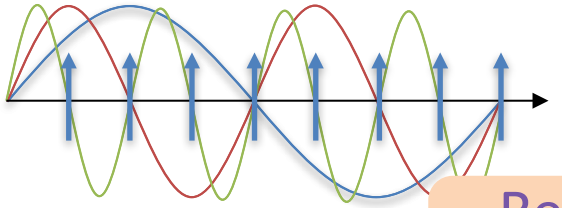
The Linear Channel Model



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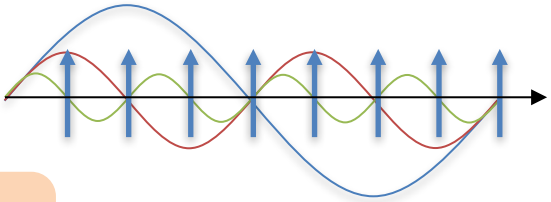
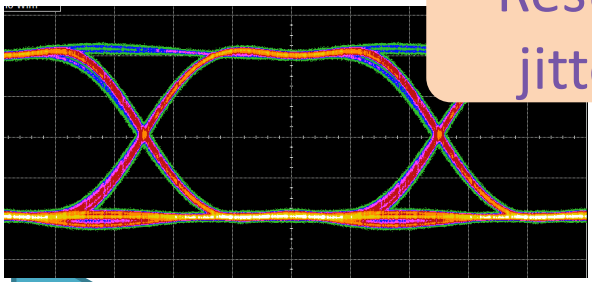
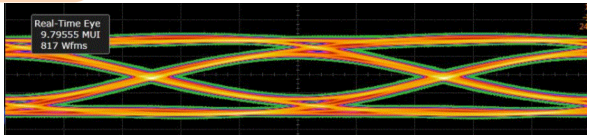


Results in almost non-realistic jitter injection requirements





Linear Channel

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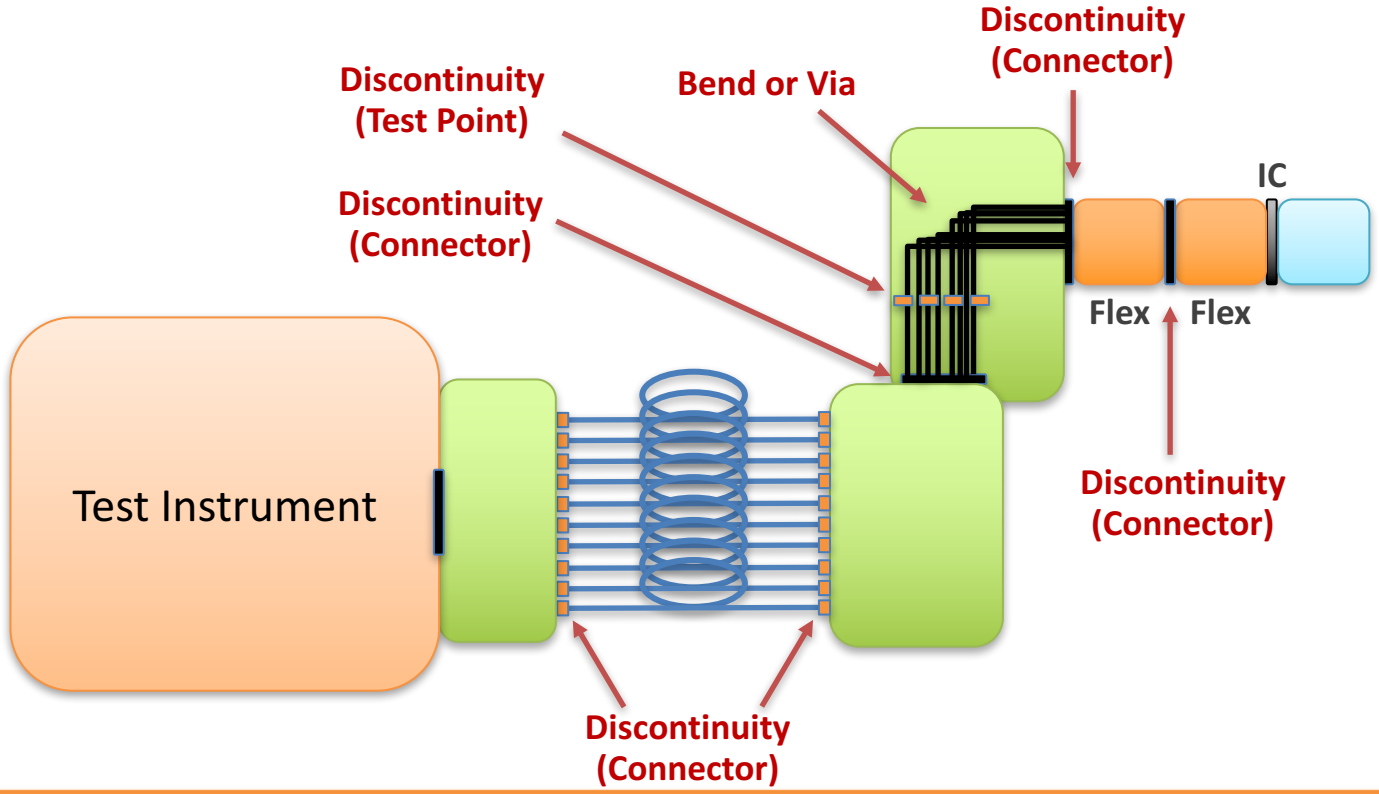
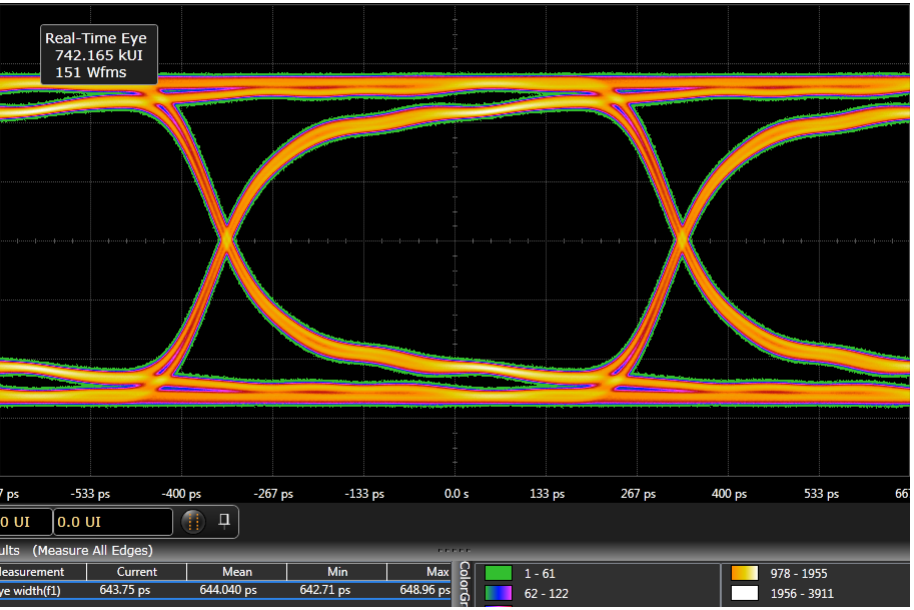
Practical Evaluation Board… Nonlinear!

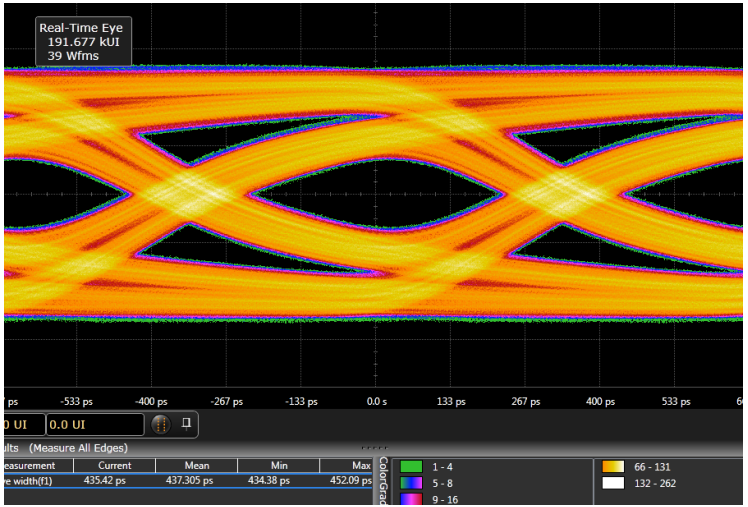


Linear Channel Versus Non-Linear Channel

Tx Eye Diagram



Linear Channel Eye Diagram (~0.3 UI Closure)



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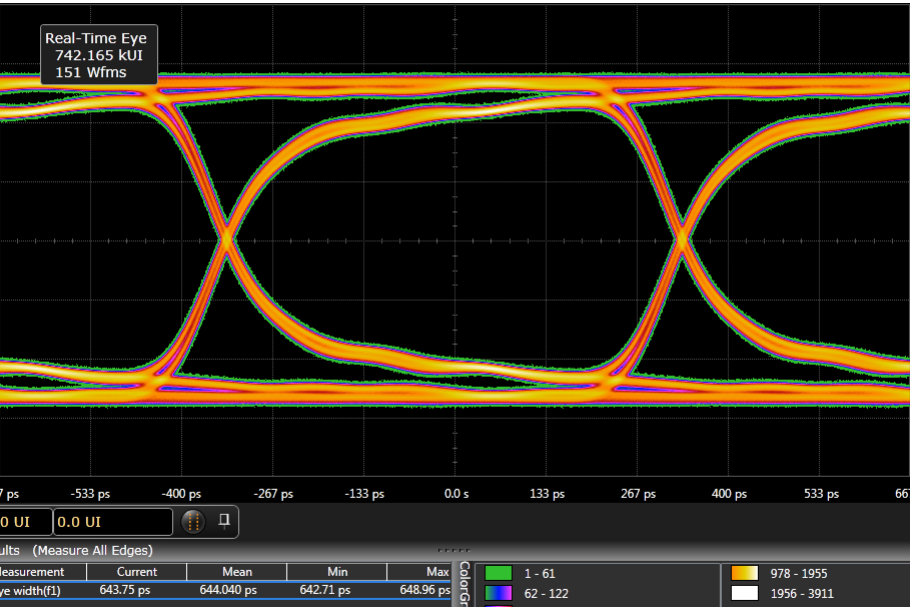
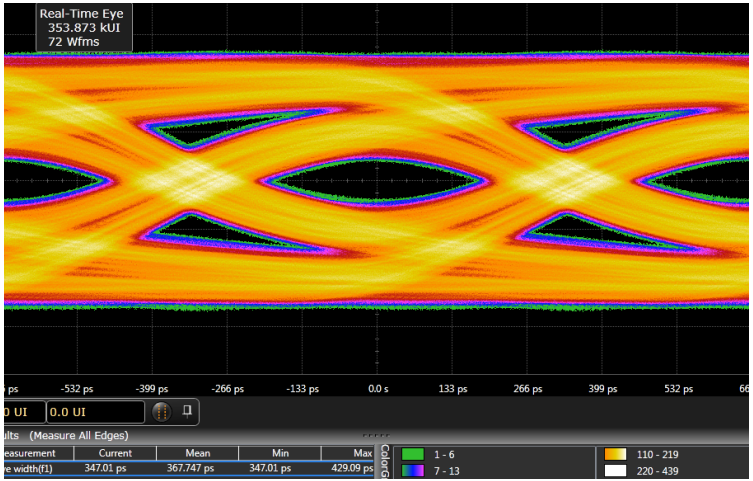
Linear Channel Versus Non-Linear Channel

Tx Eye Diagram



Non-Linear Channel Eye Diagram (~0.4 UI Closure)
Channel is 25% Shorter



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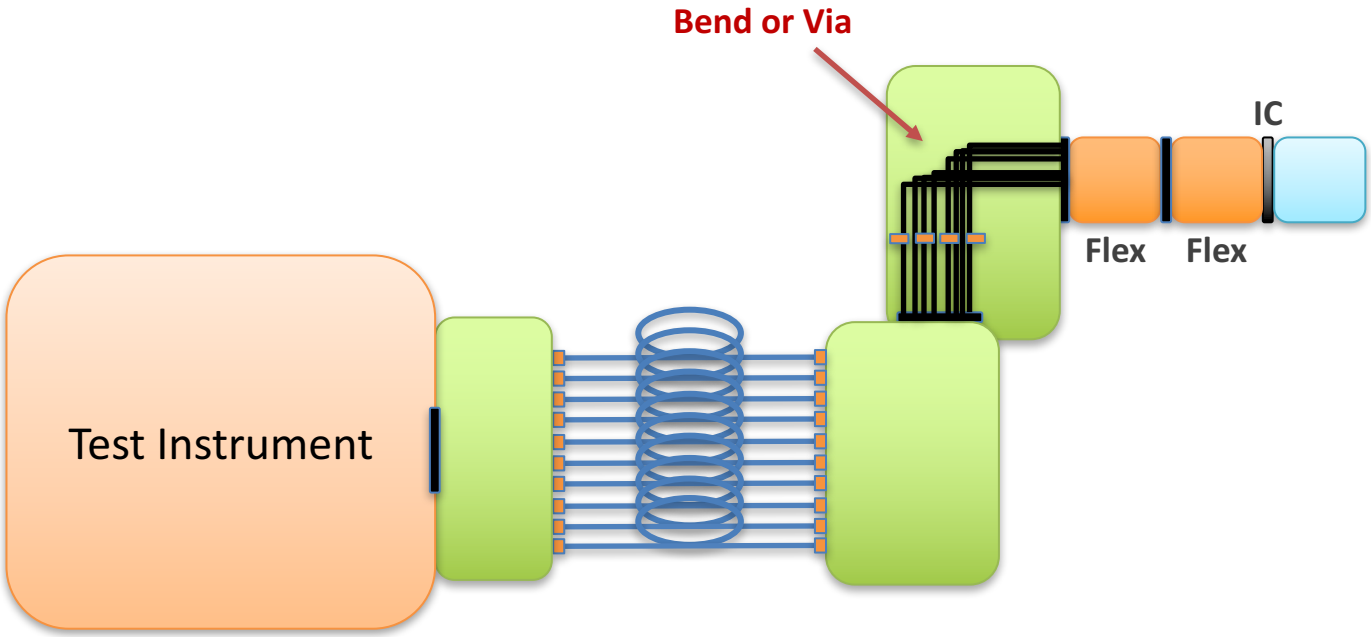
Practical Experiences: Skew



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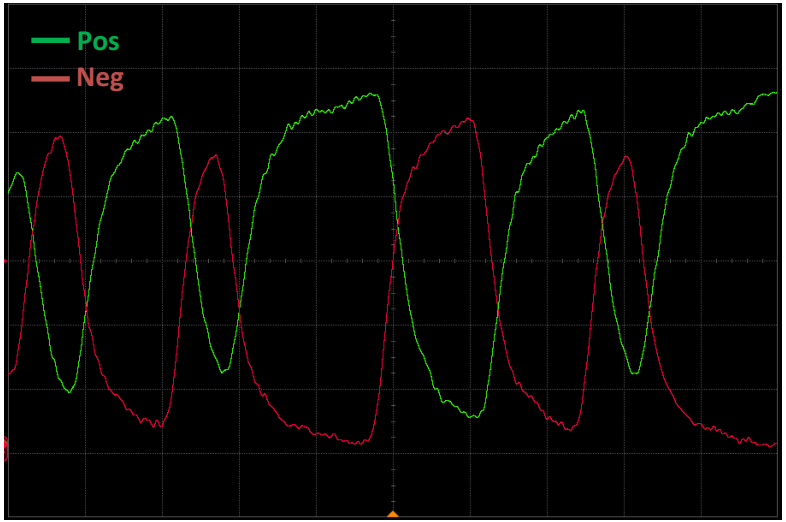
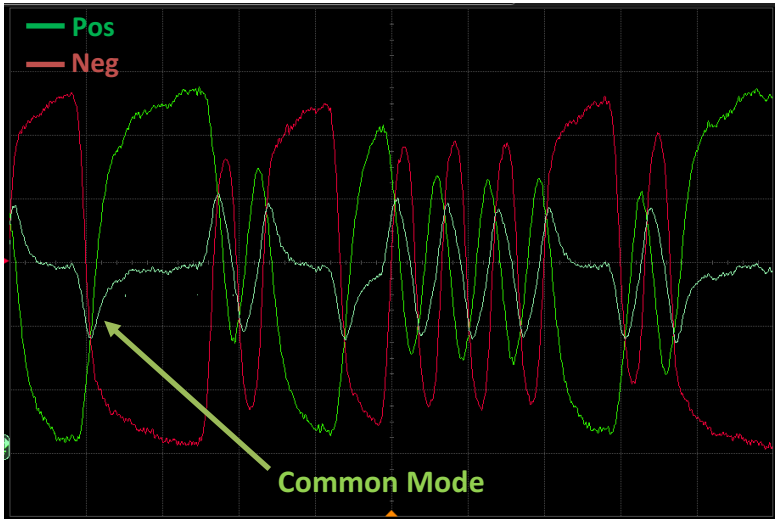
Practical Experiences: Skew

Skew introduces common-mode noise (not good for receiver!)

Difficult to detect on differential scope eye diagram





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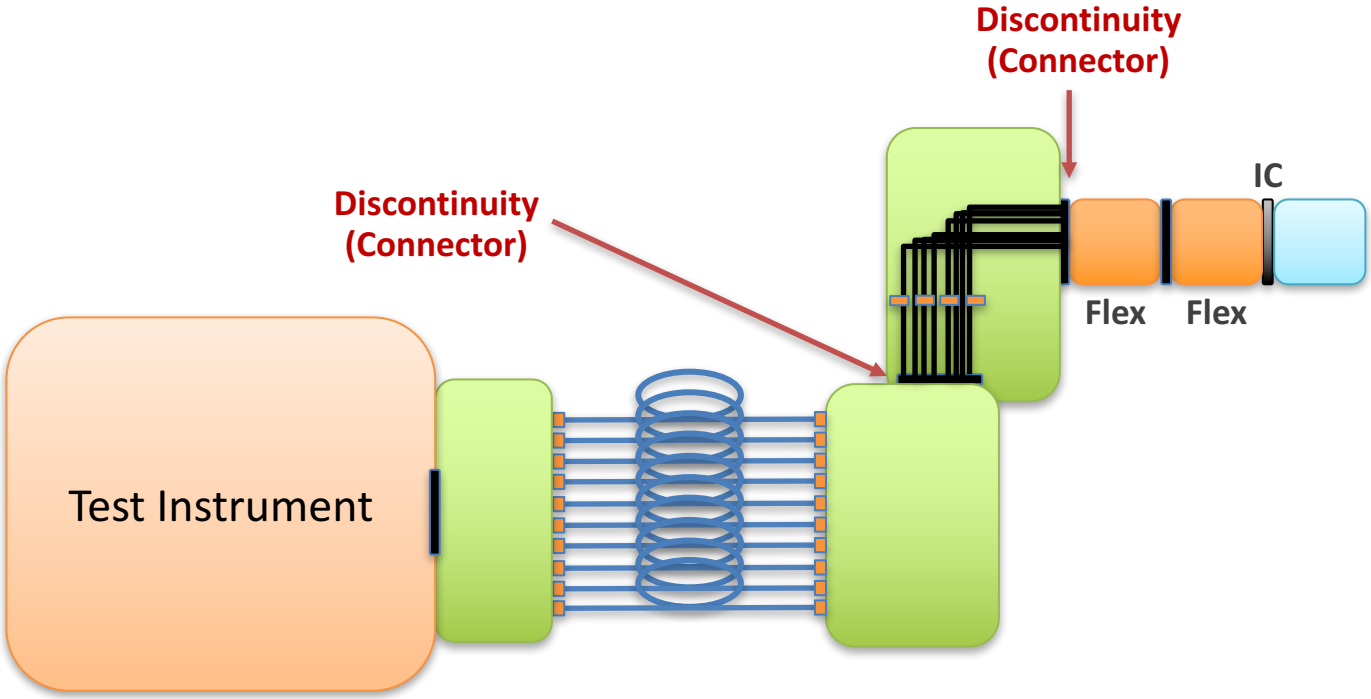
Practical Experiences: Reflections



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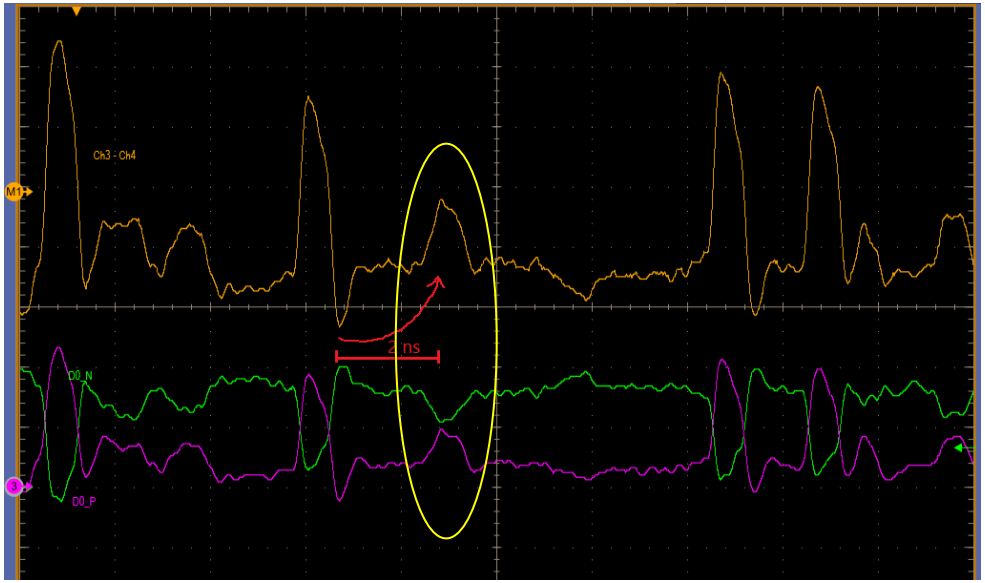
Practical Experiences: Reflections

Worst-case example of a channel non-linearity

Signal rise time is sharp, but reflections can cause bit flips



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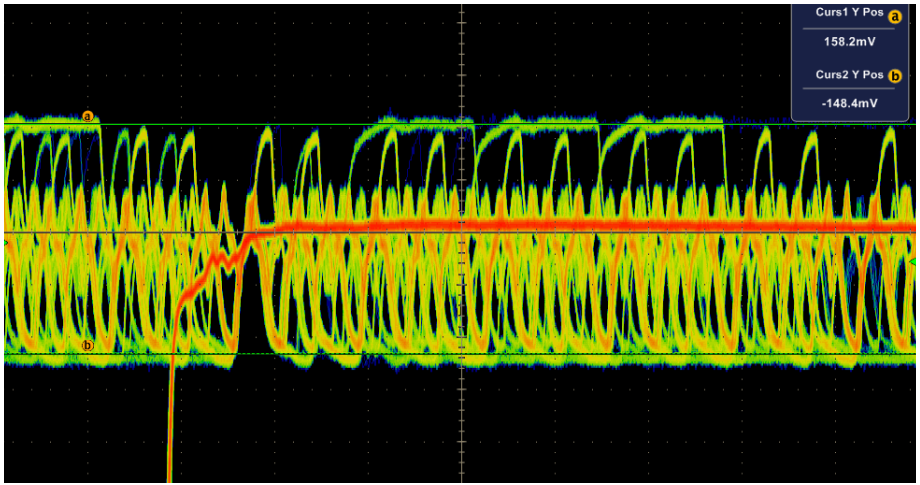
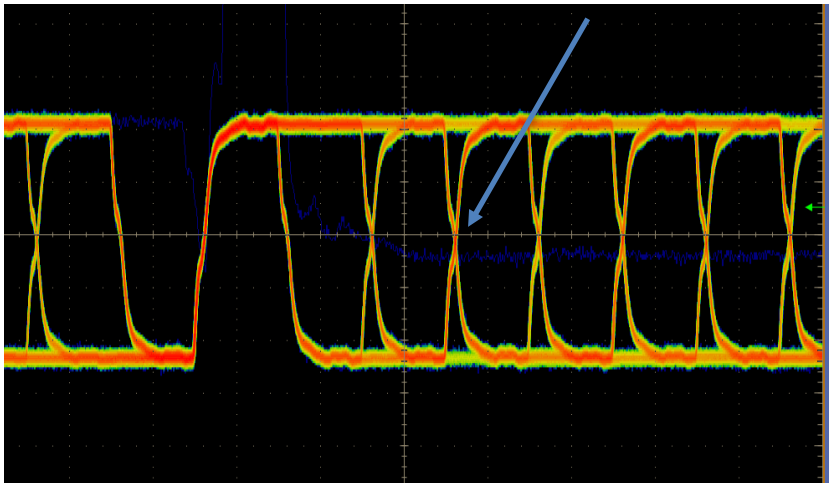
Practical Experiences: Reflections

Stub Causing Complete Eye Closure



Slowing Data Rate Reveals Stub Waveform



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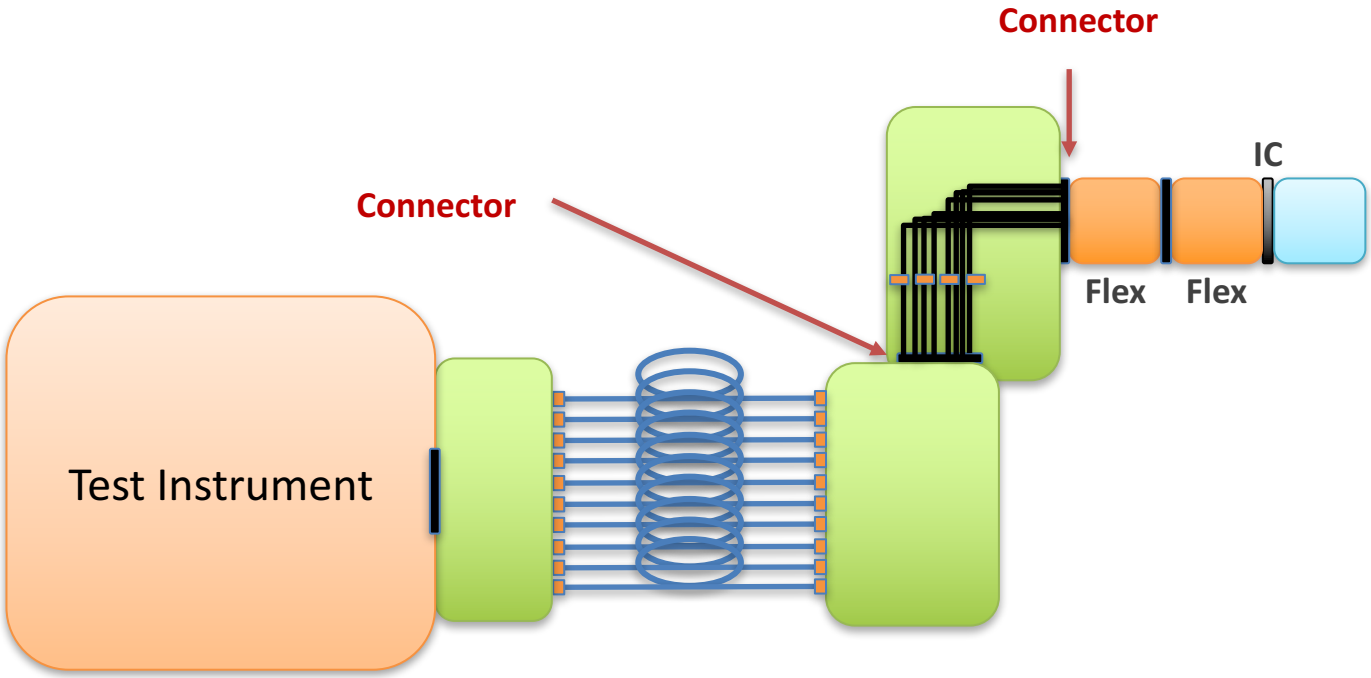
Practical Experiences: Grounding



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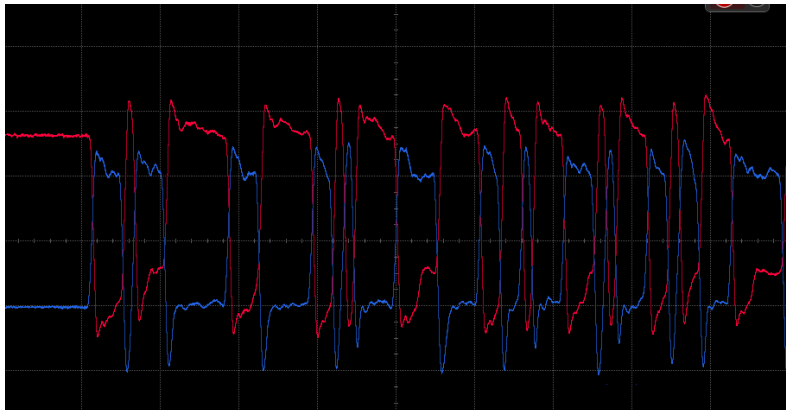
Practical Experiences: Grounding

HS eye diagram affected by CM and Diff effects

LP waveforms affected by crossing levels and reflections



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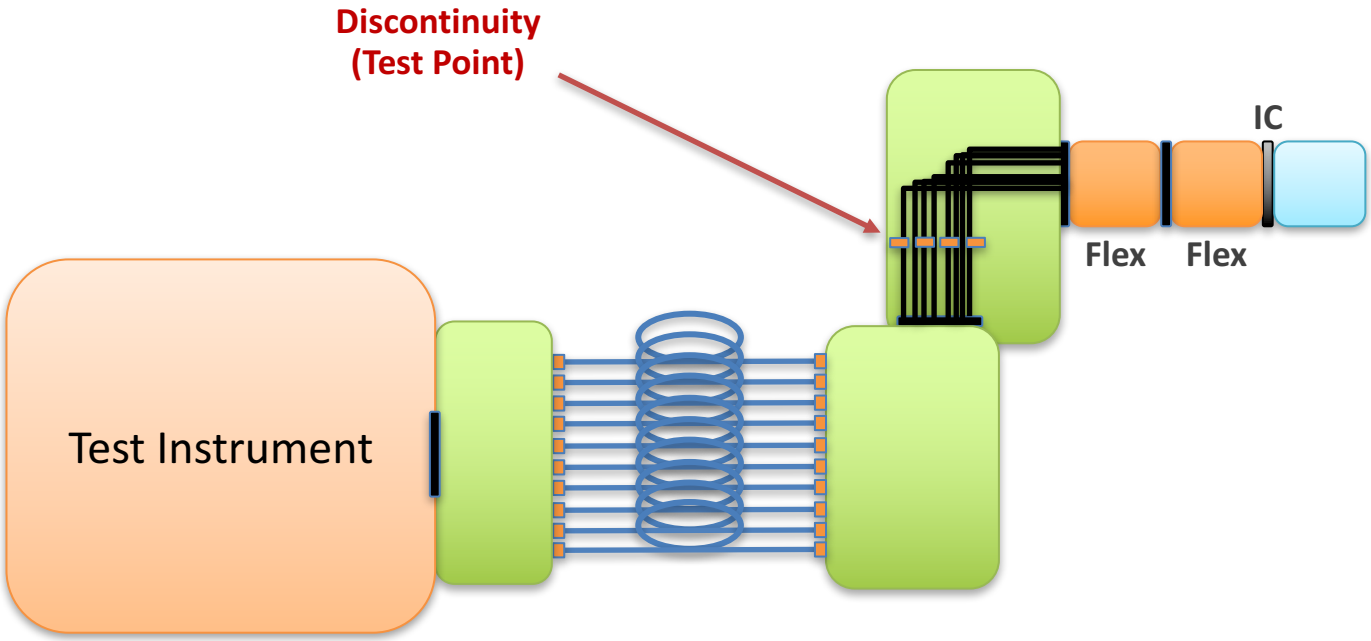
Practical Experiences: Inductance



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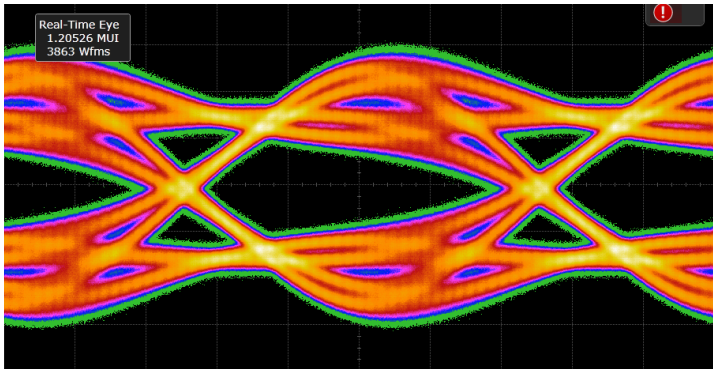
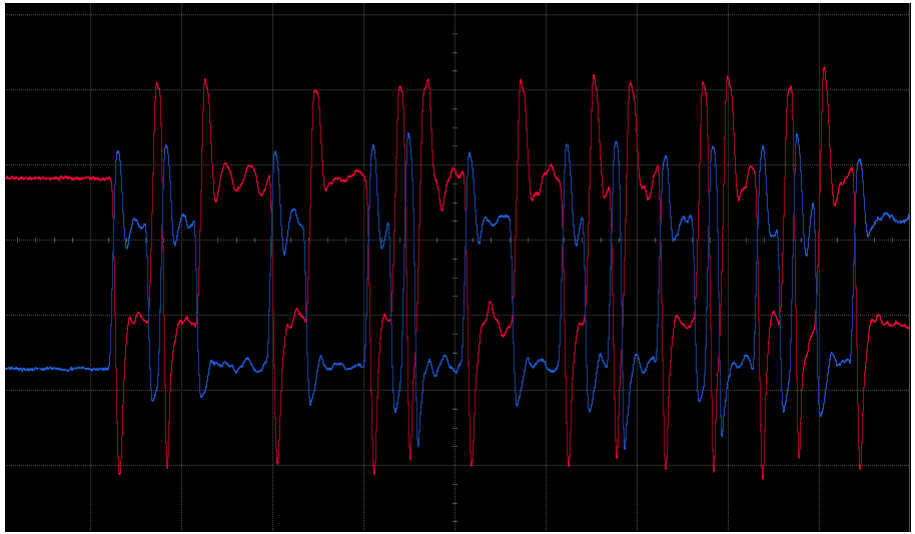
Practical Experiences: Inductance

Often due to test points

Makes correlation with specifications difficult





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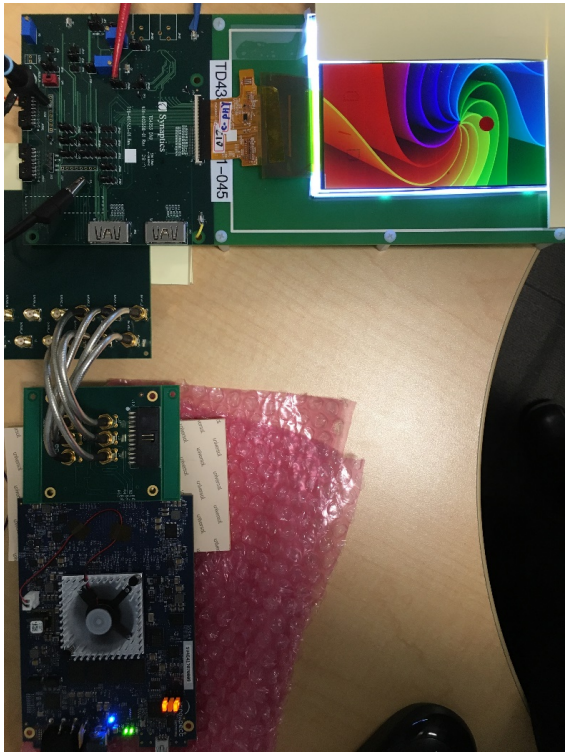
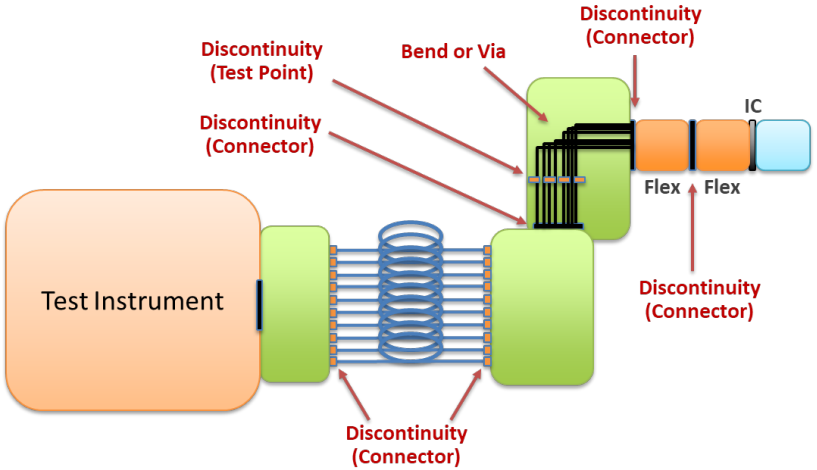
Recommendations





Adopt a **system-level approach to test** if your evaluation board looks like a system

Identify stress parameters **suitable for characterizing your device** in its environment

Characterize receiver performance **across system constraints** as well as through ideal “linear” channel

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