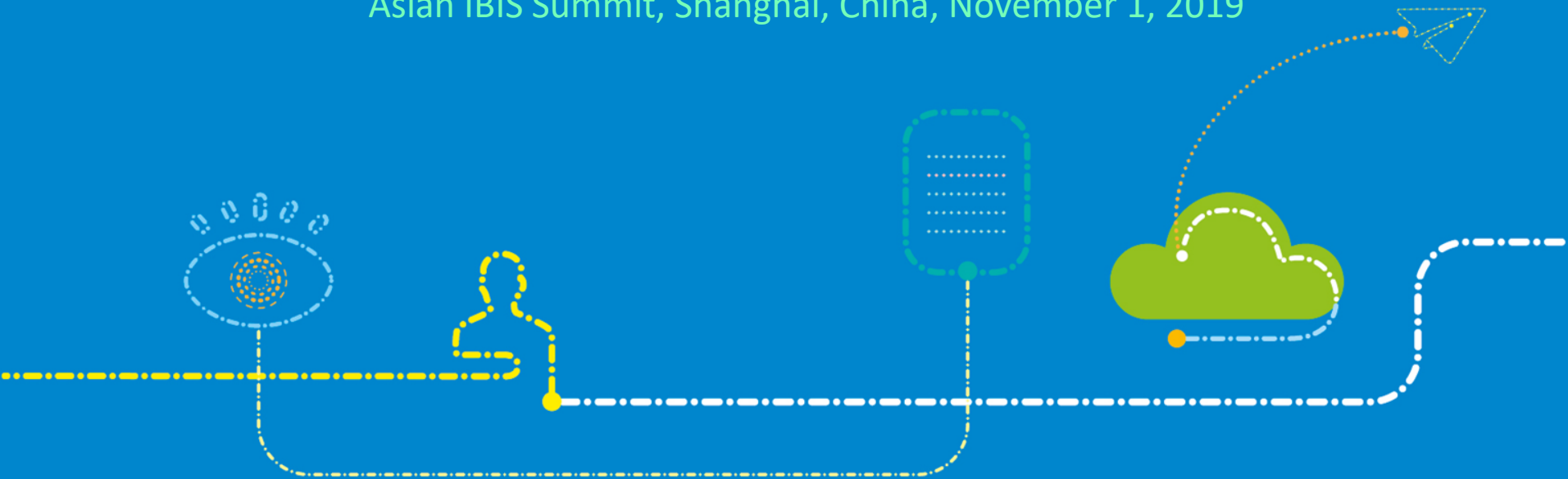


How To Fix a Short Channel Problem With AMI and COM Simulation

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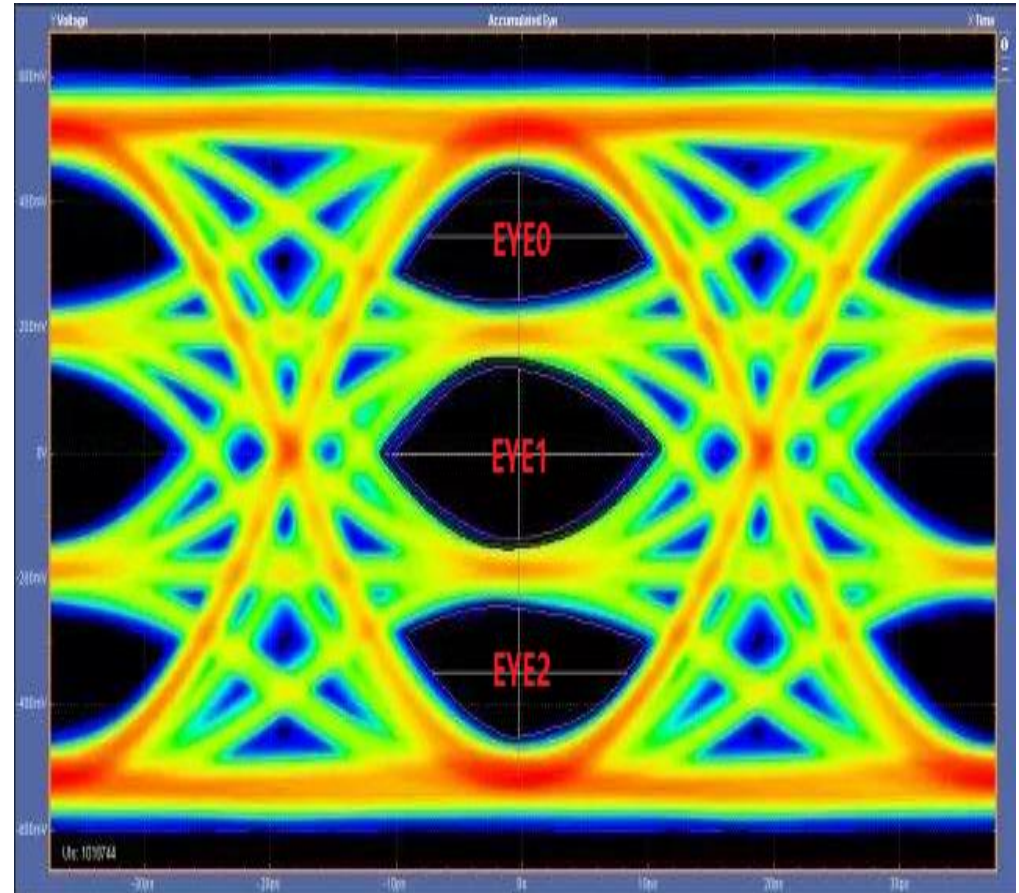
Agenda

- Overview
- Test Phenomenon
- AMI and COM Simulation
- Summary



Overview

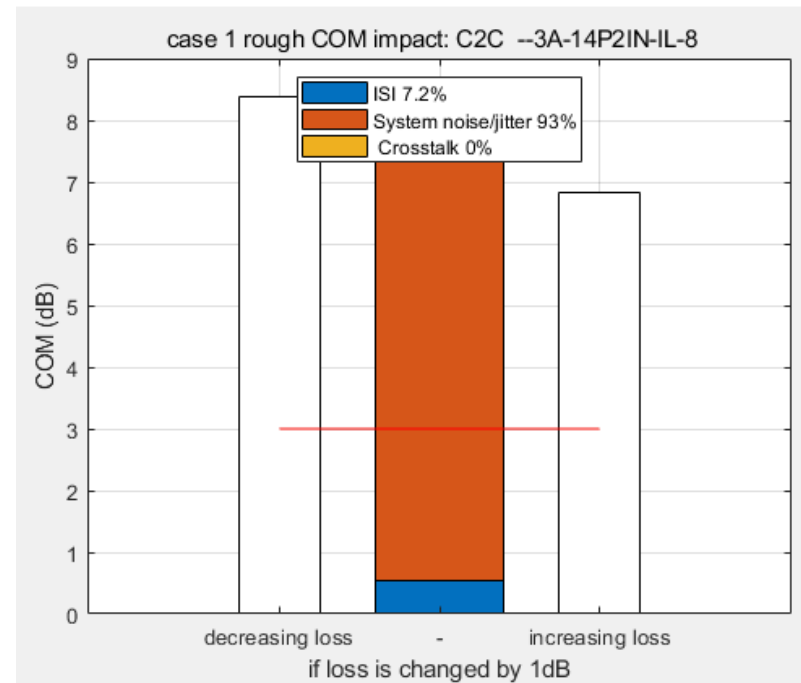
- Channel active simulation
 - Channel Operating Margin (COM)
 - AMI
- Introduce
 - The PAM4 signal has three eyes
 - The quality of the signal should be determined by the smallest eye
 - Eye width/height@BER



Overview

- Concerned parameters in COM simulation results
 - COM
 - ERL
 - The percentage of interferences
 - ...
- Concerned parameters in AMI simulation results
 - Eye width@BER
 - Eye height@BER

```
: Case 1: z_p=(12, 12, 12, 12) (TX, RX, NEXT, FEXT):: COM = 6.790 dB  
(pass)  
: PASS ... ERL = 17.400 dB
```

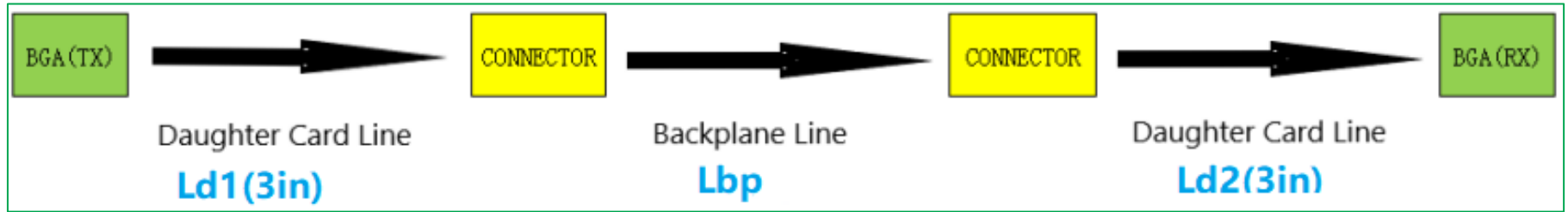


Agenda

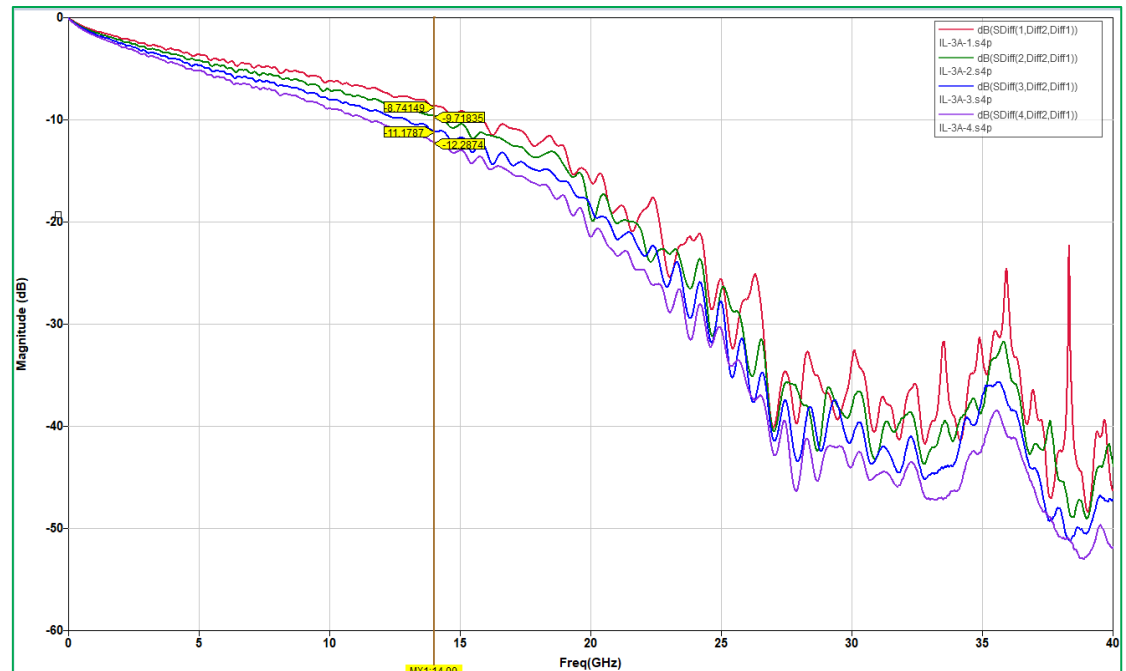
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Test Phenomenon



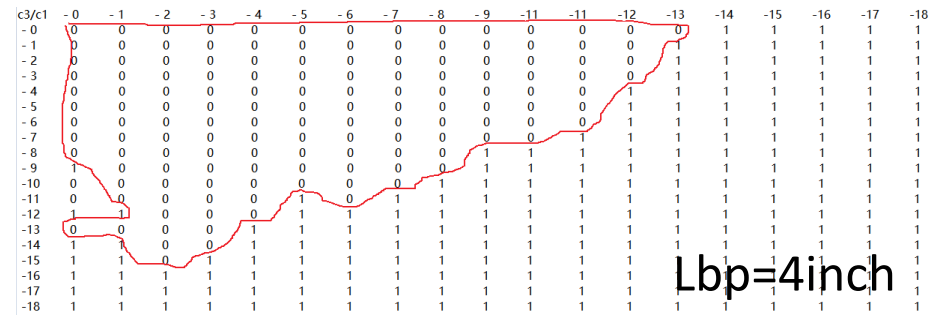
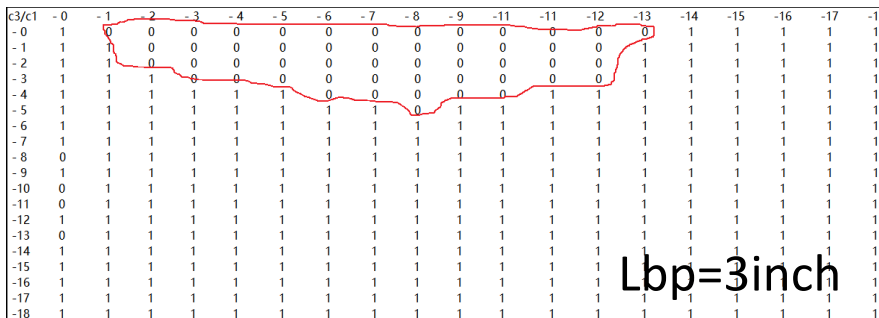
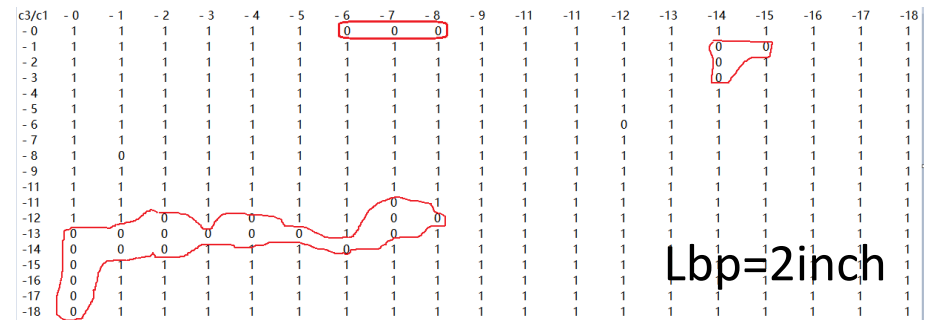
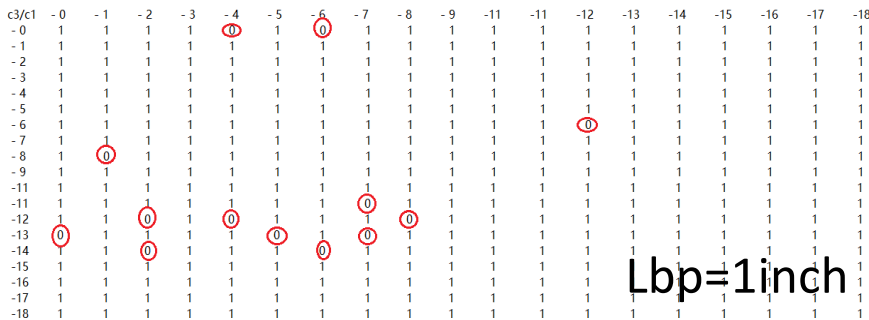
- System channel: CEI-56G-LR-PAM4
- Daughter card trace length Ld1, Ld2 (3inch)
- Backplane trace length Lbp (1inch/2inch/3inch/4inch)
- Without Crosstalk



Test Phenomenon

A group of results with varying parameters of the four channels are presented as follows.

- 0: pass,1: fail
- When the channel length is 1inch, only a few parameters meet the requirement of BER
- With the increase of channel length, the parameters that meet the requirements of BER increase, and the system margin increases as well



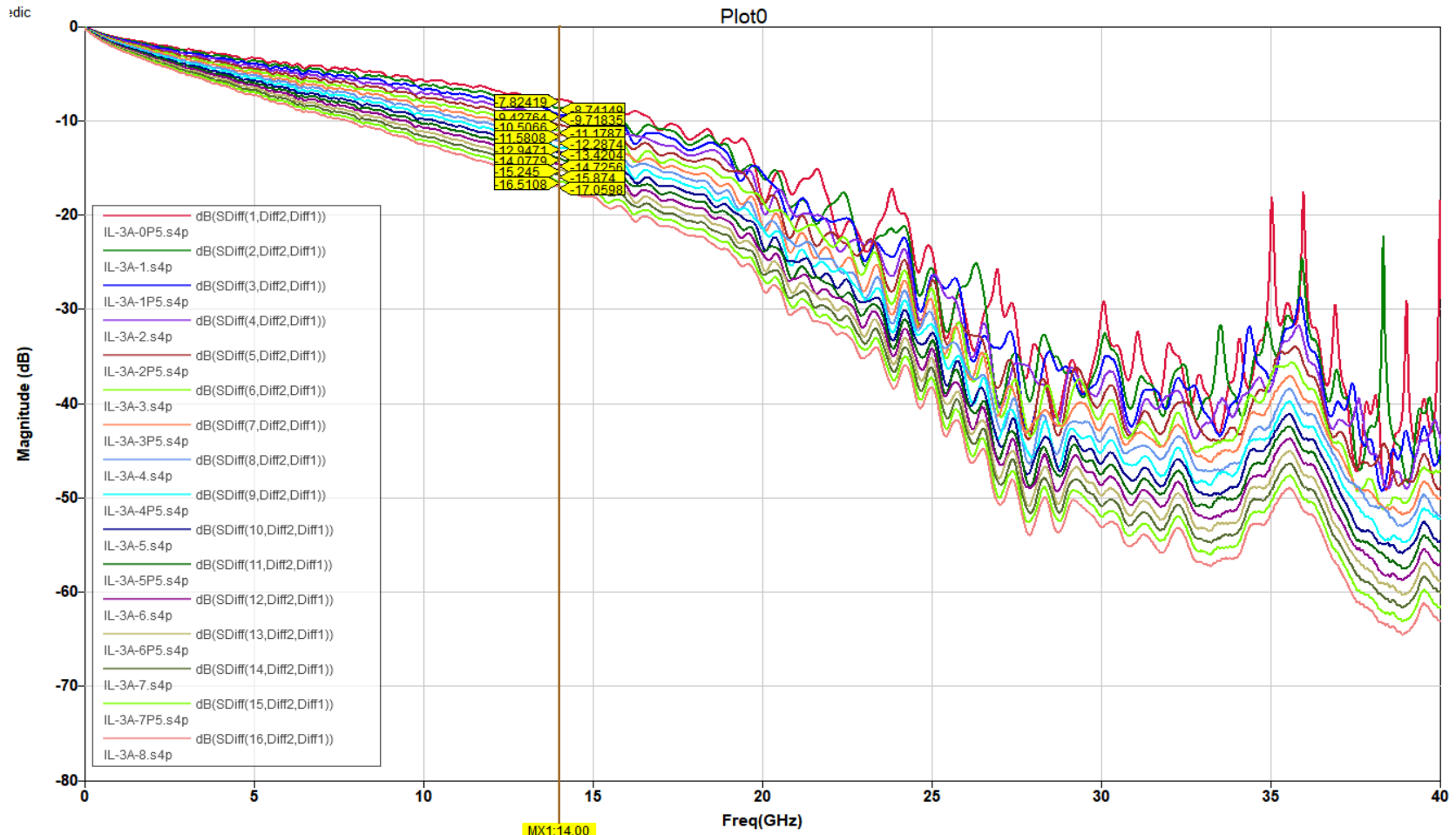
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AMI and COM Simulation

- Channel: 16 different simulation channels
- Without Crosstalk
- Backplane line length: Lbp [range: 0.5 to 8inch,step: 0.5inch]



AMI and COM Simulation

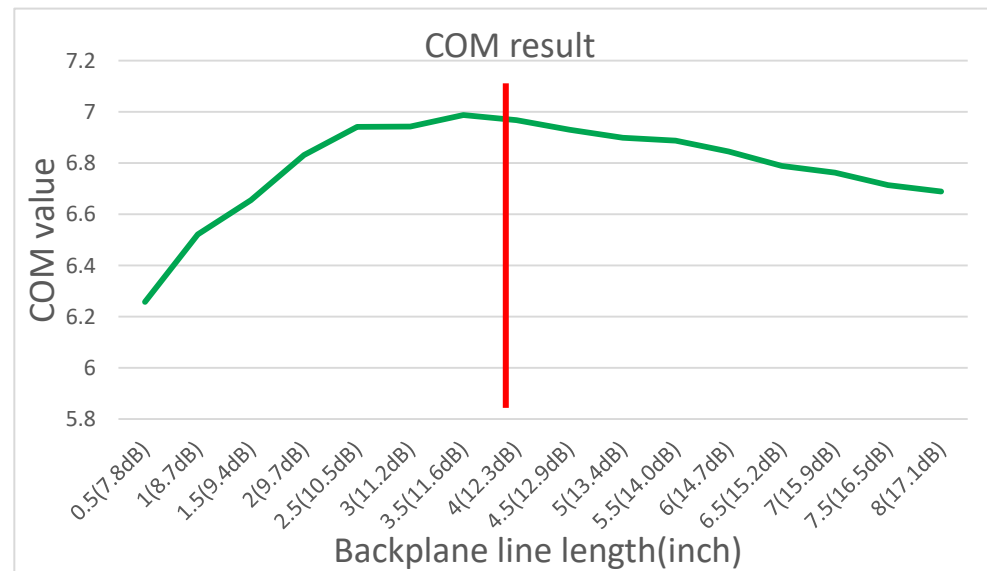
AMI Simulation Result

- Inconsistent with the trend of actual test results
- The eye width and height decrease with the increase of channel length, leading to a decay in system margin



COM Simulation Result

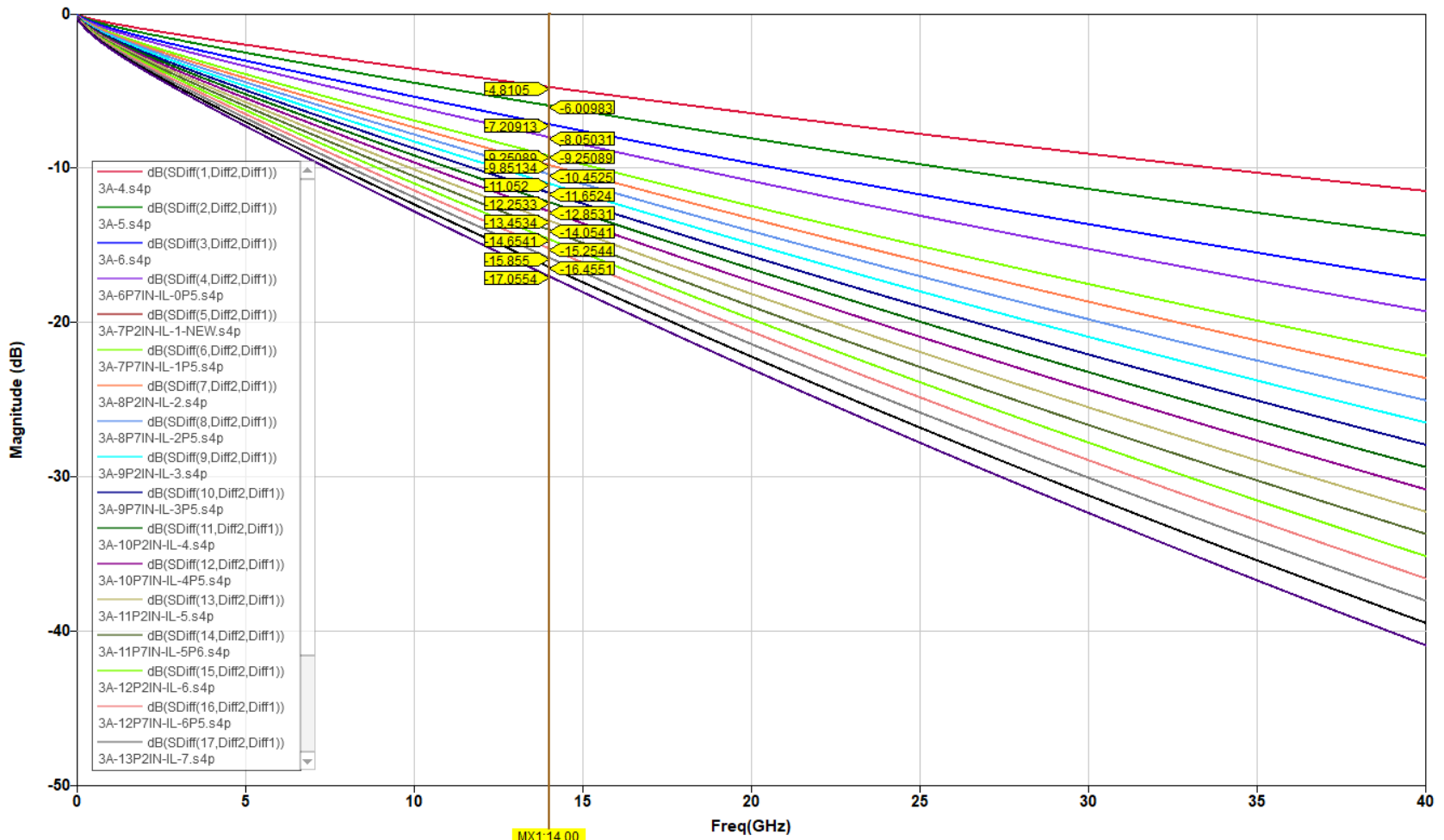
- Consistent with the trend of actual test results
- COM value increases with the increase of backplane line length at first.
- After peaking, COM value then starts to decrease while the backplane line length continues to increase



AMI and COM Simulation

Whether the above rules and differences are caused by the connector?

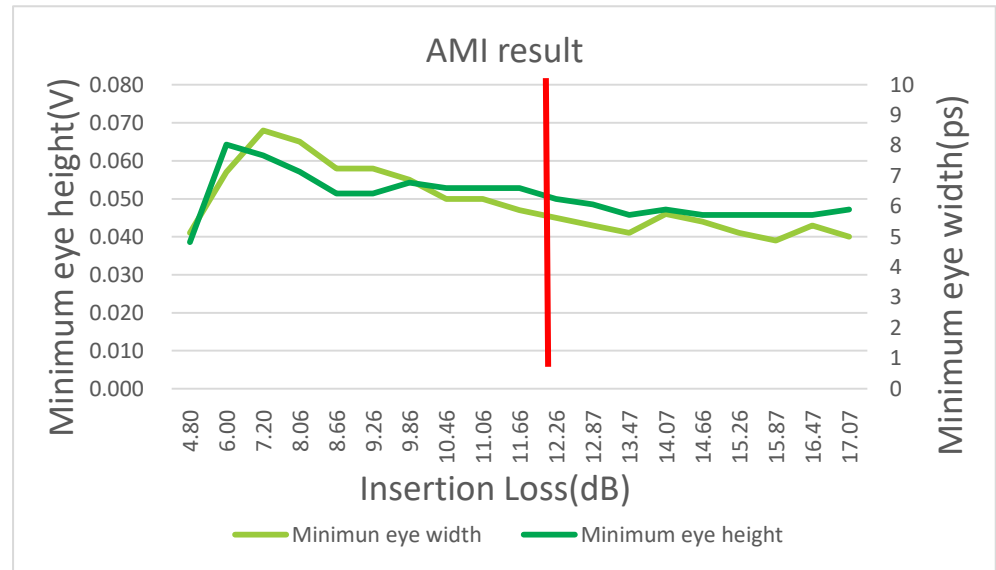
- Remove the connector and Footprint (excluding the impact of ILD, SKEW and RL)
- Use transmission line channel verification only



AMI and COM Simulation

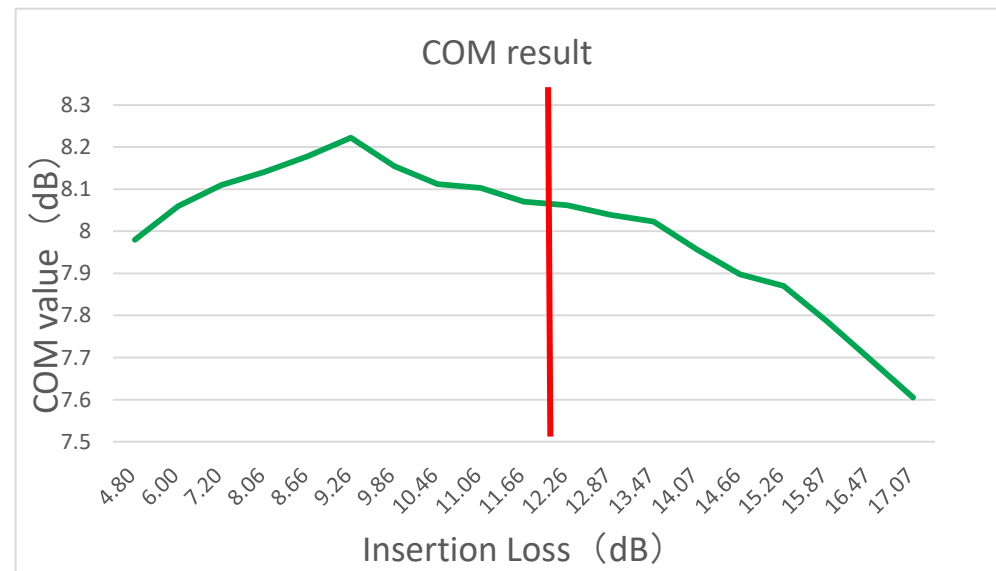
AMI Simulation Result

- Trends become similar to COM results.
- The eye width and height increase with the loss increases at first
- The eye width and height then starts to decrease while the loss continues to increase



COM Simulation Result

- Consistent with the trend of actual test results
- COM value increase as loss increases at first
- After peaking, COM value then start to decrease while loss continues to increase



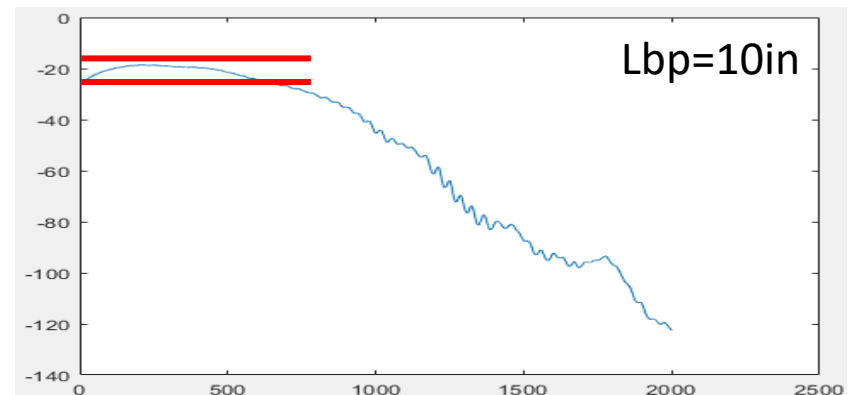
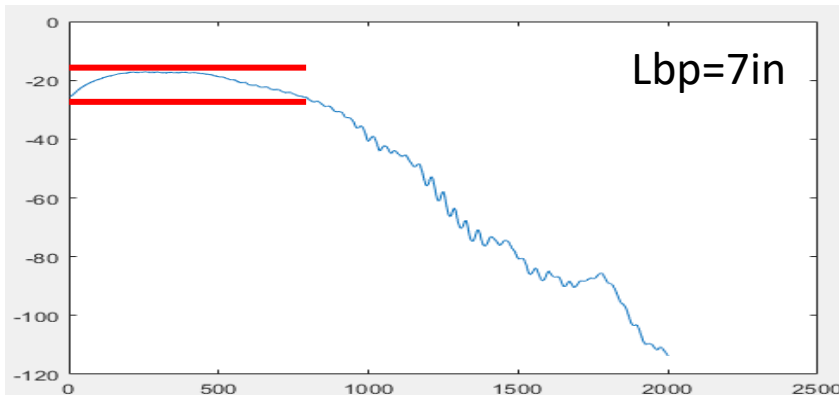
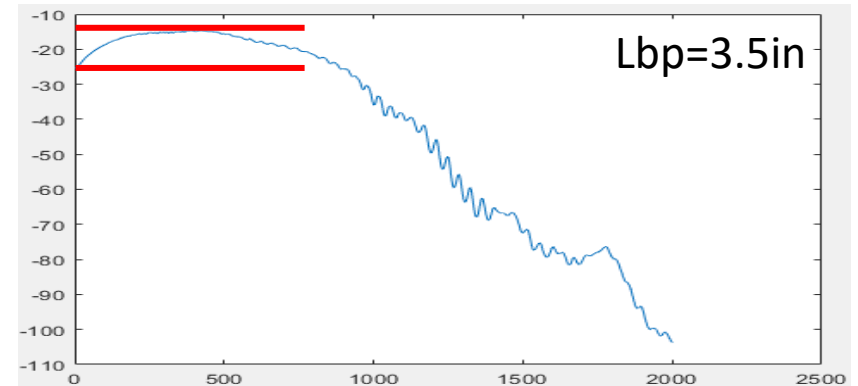
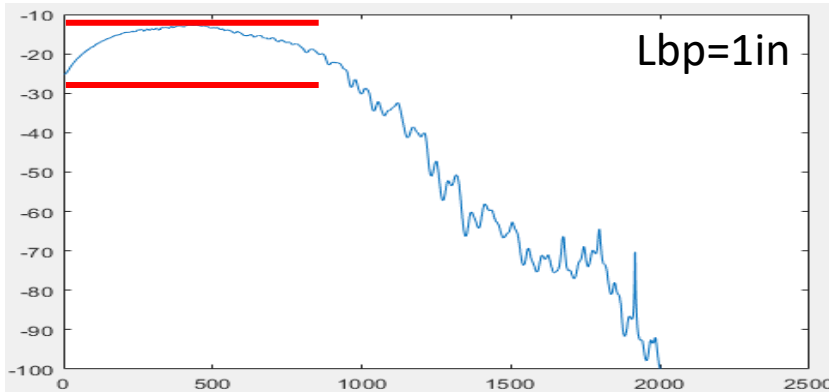
AMI and COM Simulation

Why do such rules appear?

COM simulation can provide more information compared to AMI simulation

COM simulation tool supports to export insertion loss curve after CTLE

- For short channel, the compensation in insertion loss is too much at low frequency
- With the increase of channel length, the compensation in insertion loss at high and low frequency tends to balance



AMI and COM Simulation

The comparison of the influence of CTLE on channel is shown in the following table

- For short channel, CTLE has little influence on ISI
- For long channel, CTLE has a great influence on ISI
- When CTLE is operating, the proportion of ISI in short channel is greater than that of long channel

When the channel insertion loss is very small, CTLE compensates too much for the insertion loss at low frequency band, which is not conducive to reducing ISI

Length of line in Backplane	CTLE	COM12MM	FOM	ASV	seg_ISI	ISI/ASV
1in	off	6.2315	17.4946	35.9423	0.0028494	7.93%
	on	6.5206	17.7784	35.8026	0.0025736	7.19%
10in	off	4.8362	16.1031	15.4962	0.0016943	10.93%
	on	6.4419	17.6499	10.9379	0.00065234	5.96%

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Summary

- When the channel insertion loss is very small, CTLE compensates too much for the insertion loss at low frequency band, which is not conducive to reducing ISI
- In high-speed design, the length of the channel should be designed meeting the requirements of a certain value
- During AMI simulation, it will be more helpful to find problem if more detailed information can be output (such as CTLE curve).
- When analyzing problems, it is recommended that both COM and AMI simulation should be done if possible.

Thank you



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