Analysis on the Impact of Reflection on the Link Performance of the 112G System

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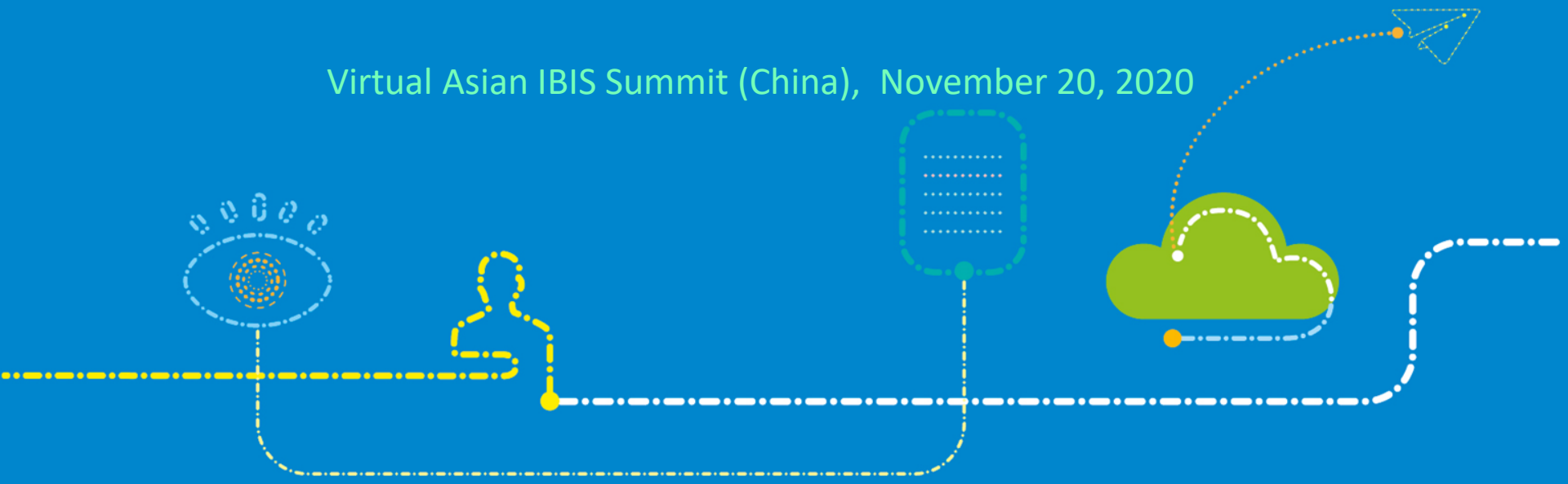


Agenda

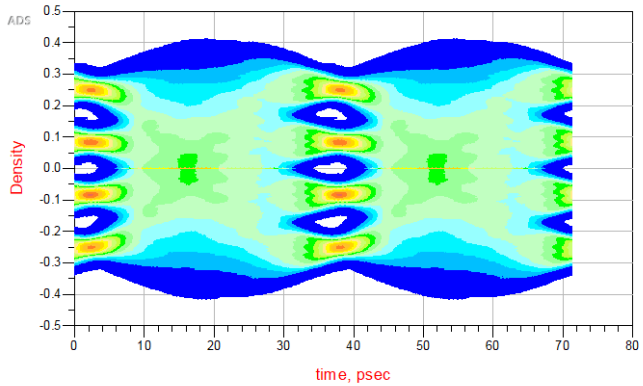
- Introduction
- ERL&COM
- Analysis of Short Channel Reflection
- Analysis of Long Channel Reflection
- Summary

Why Is Reflection So Important?

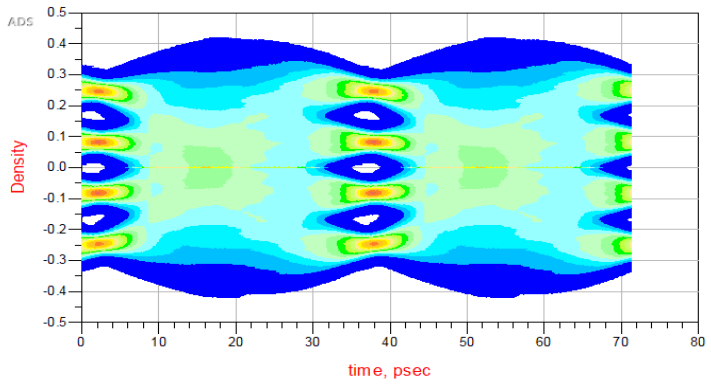
- Return loss is a very important channel indicator, especially when the SerDes data rate reaches 112Gbps.
- Reflection can cause a blurred eye, like noise.

EXAMPLE:Decrease ERL by 3 dB to worsen the eye width 16.8%

	Transmission line impedance	Depth of connector footprint	Others	ERL	Eye width (BER=1E-5)	Changed percentage
ChannelA	90Ω	3mm	The length of transmission lines, connector types, and materials of this two channels are all the same	13.26 dB	5.36 ps	0
ChannelB	80Ω	1mm		10.13 dB	4.46 ps	-16.8%



index	permute(WidthAtBER1)	permute(HeightAtBER1)
0.000	5.357E-12	0.037



index	permute(WidthAtBER1)	permute(HeightAtBER1)
0.000	4.464E-12	0.036

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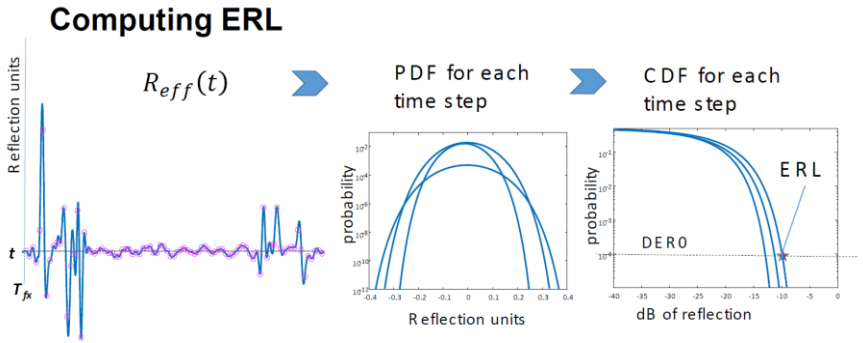
What Is ERL?

- IEEE802.3 specification
- A figure of merit for the electromagnetic wave reflection from the impedance discontinuous points

The effective reflection waveform is calculated through the following formula:

$$Reff(t) = PTDR(t) TG_{rr}(t) TG_{loss}(t)$$

The echoed pulse response of a single symbol is convolved with the modulation signal levels to produce an effective reflection coefficient metric at a specified bit error ratio (BER).



What Is COM?

- The Channel Operating Margin (COM) is a figure of merit for a channel derived from its scattering parameters
- A ratio between available signal amplitude and noise amplitude
- Widely recognized and used in the practice

$$COM = 20\log\frac{A_s}{A_{ni}}$$

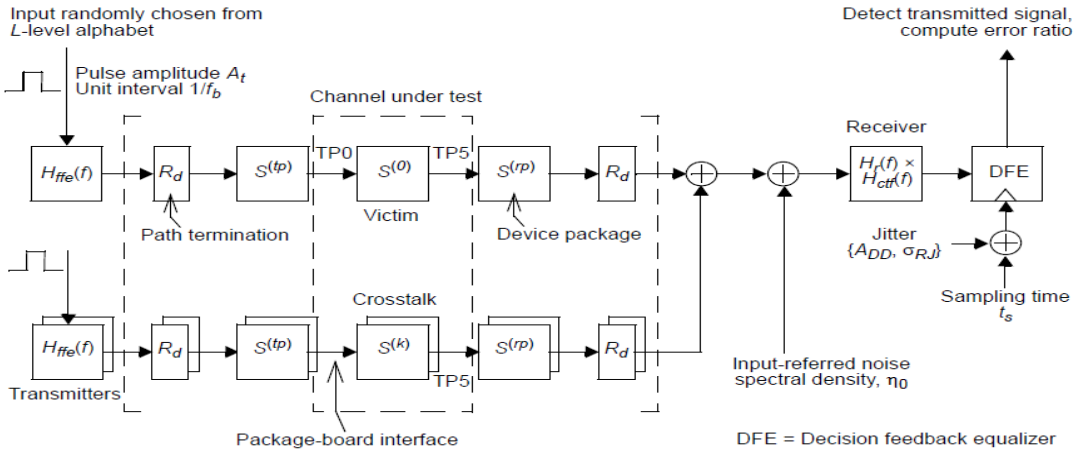


Figure 93A–1—COM reference model

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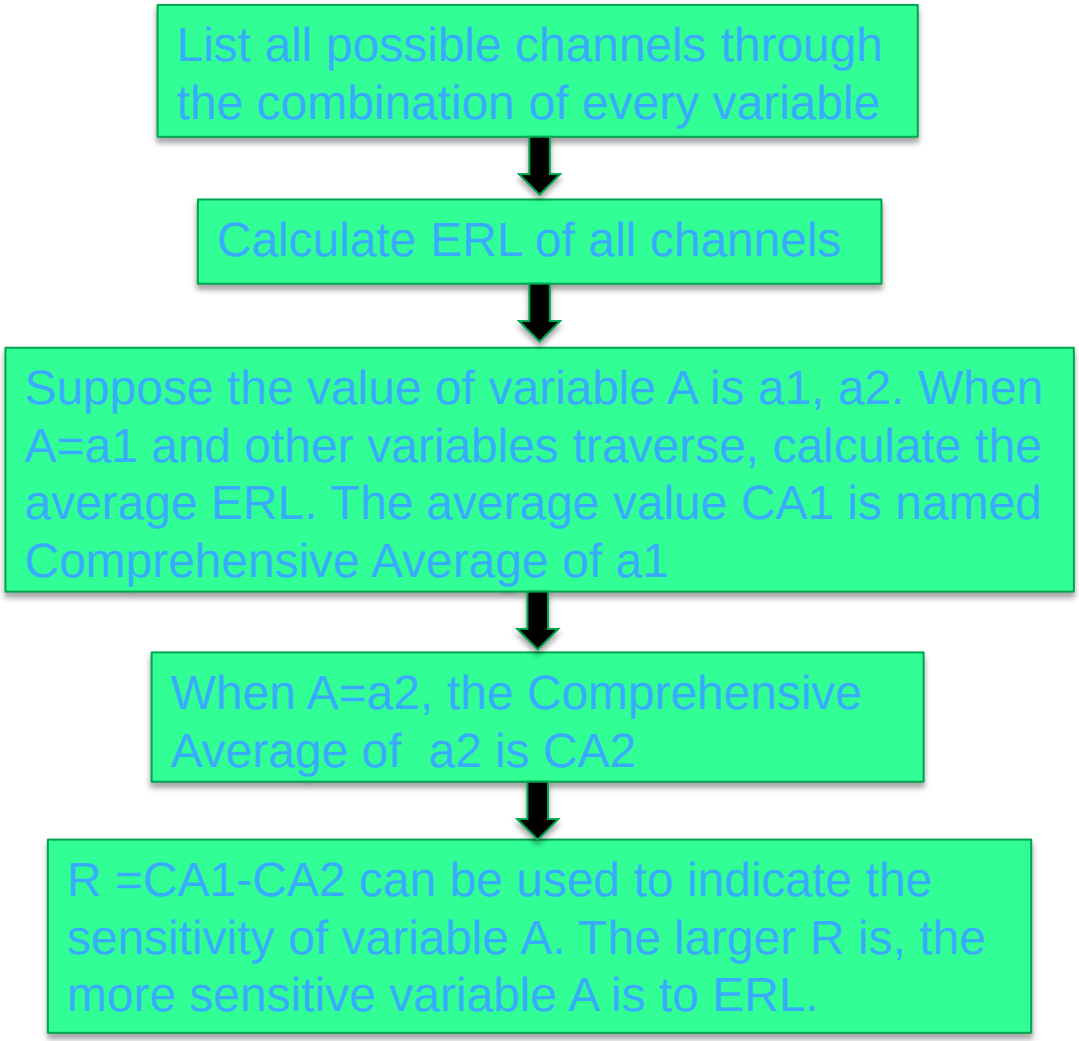
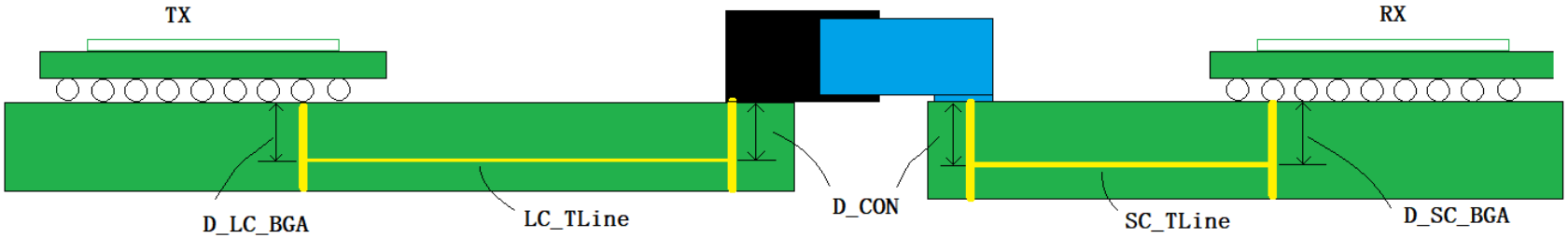
Sensitivity Analysis Algorithm



Information of Each Component in The Channel.



Variable	Description
D_LC_BGA	Depth of BGA-fanout-hole in line card
LC_TLine	Transmission line in line card
D_CON	Depth of OD connecter footprint hole
SC_TLine	Transmission line in switch card
D_SC_BGA	Depth of card BGA-fanout-hole in switch

Short Channel Analysis of ERL

Calculate the ERL of 72 groups of data, then analyze the ERL of the short channel by using the Sensitivity Analysis Algorithm

	D_LC_BGA	LC_TLine	D_CON	SC_TLine	D_SC_BGA
Low	11.55	11.41	10.91	11.43	11.70
Normal	NA	11.38	NA	11.40	NA
High	10.91	10.90	11.54	10.85	10.75
R_ERL[1]	0.64	0.51	0.63	0.58	0.95

Low： **Impedance fluctuation -10% or short hole**

Normal： **design impedance**

High： **Impedance fluctuation +10% or long hole**

NA： **Not Available**

R： **Sensitivity**

Conclusion:

- ERL is most sensitive to the change of BGA-fanout-hole depth.
- The influence of the connector footprint hole depth on the ERL is secondary

Note1:R_ERL indicates variable R in ERL analysis

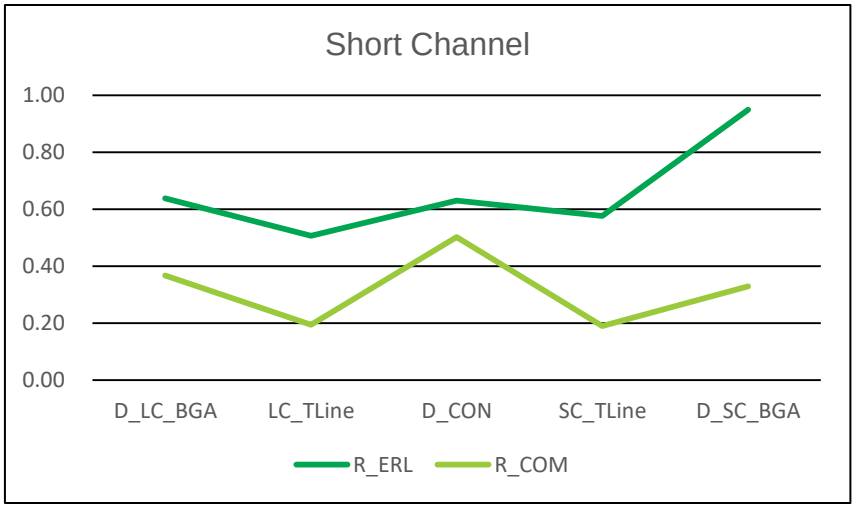
Short Channel Analysis of COM

Calculate the COM of 72 groups of data, then analyze the COM sensitivity of the short channel[1]

	D_LC_BGA	LC_TLine	D_CON	SC_TLine	D_SC_BGA
Low	6.96	6.83	6.52	6.85	6.94
Normal	NA	6.85	NA	6.82	NA
High	6.59	6.65	7.03	6.66	6.61
R_COM[2]	0.37	0.19	0.50	0.19	0.33

Conclusion:

In the case of short channel, the sensitivity of each component to the ERL almost has the same trend as that of each component to the COM (see the figure on the right), which means that the ERL plays a critical role in the channel characteristics.



Note1:The IC package model come from IEEE802.3bj annex 93A in COM calculating process

Note2:To distinguish from R variable in ERL analysis, R_COM is used to indicate R variable in COM analysis

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Long Channel Analysis of ERL

Calculate the ERL of 72 groups of data, then analyze the ERL of the Long channel by using the Sensitivity Analysis Algorithm

	D_LC_BGA	LC_TLine	D_CON	SC_TLine	D_SC_BGA
Low	13.89	13.50	13.00	13.34	13.53
Normal	NA	13.38	NA	13.33	NA
High	12.49	12.70	13.38	12.91	12.85
R_ERL	1.41	0.77	0.38	0.43	0.38

Low： **Impedance fluctuation -10% or short hole**

Normal： **design impedance**

High： **Impedance fluctuation +10% or long hole**

NA： **Not Available**

R： **Sensitivity**

Conclusion:

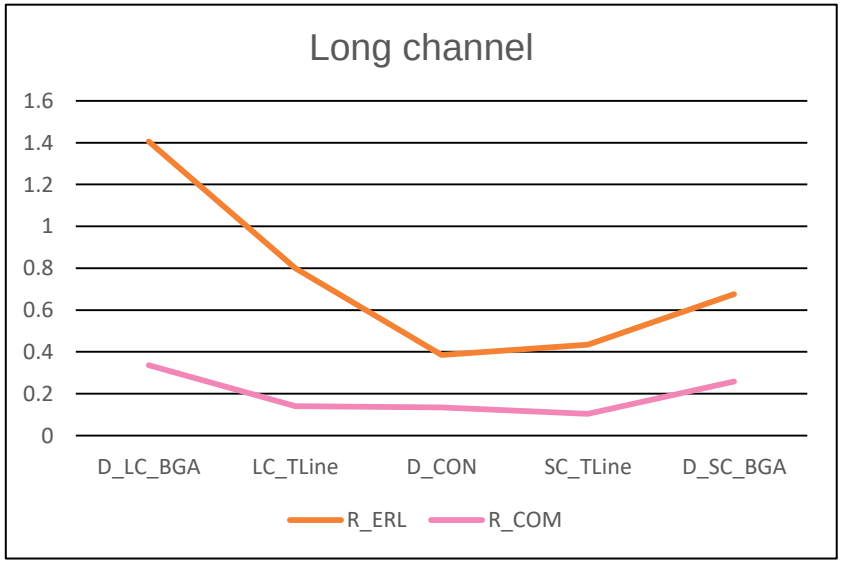
- ERL of long channels are overall better than that of short channels, which means the length of the channel will be increased by ERL.
- The depth of the BGA-fanout-hole has the greatest impact on the ERL.

Long Channel Analysis of COM

Same as short channels, we do the COM analysis for the long channel.

	D_LC_BGA	LC_TLine	D_CON	SC_TLine	D_SC_BGA
Low	5.83	5.71	5.60	5.69	5.80
Normal	NA	5.71	NA	5.70	NA
High	5.50	5.57	5.73	5.60	5.54
R_COM	0.34	0.14	0.13	0.10	0.26

Conclusion:
Again, in the case of long channel, the sensitivity of each component to the ERL almost has the same trend as that of each component to the COM (see the figure on the right).



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Summary

- ERL plays a critical role in the channel characteristics
- Long channels have overall better ERL than that of short channels
- For the short channel, a poor ERL can be improved by using shorter connector vias and shorter BGA-fanout-hole
- For the long channel, a poor ERL can be improved by using shorter BGA-fanout-hole

Thank you

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