XAUI "Hari" Electrical Update II

Ali Ghiasi

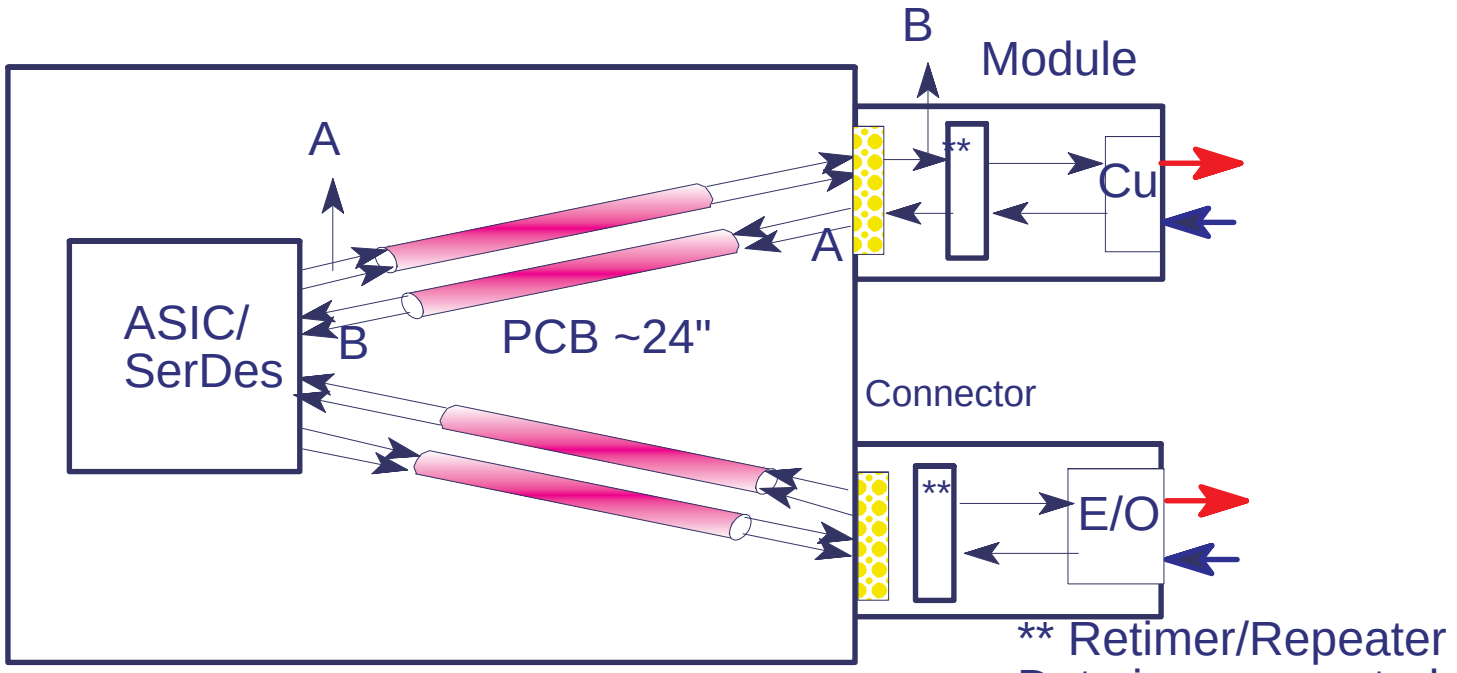
Broadcom Corporation
3151 Zanker Rd.
San Jose, CA 95134

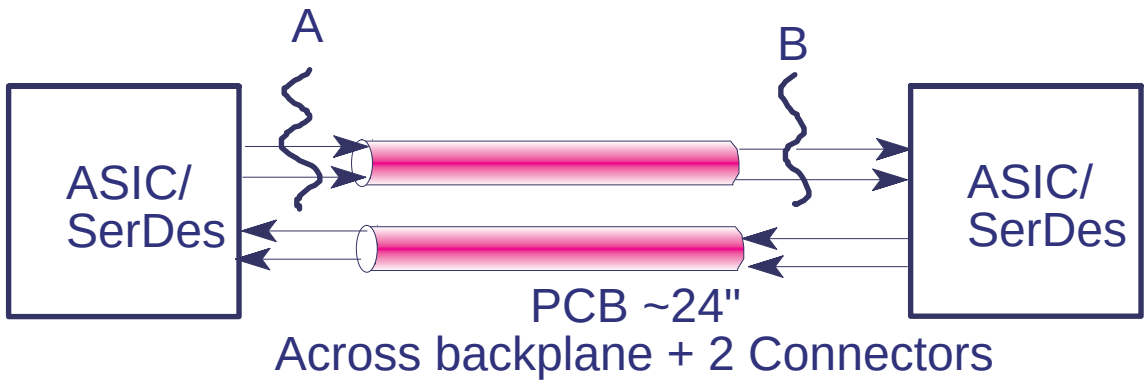
aghiasi@broadcom.com

Overview

- Overview of XAUI Implementation.
- PCB power budget and proposed allocation.
- ISI calculation and limits.
- PCB distance vs transmitt amplitude.
- Symbol skew introduction by SerDes TX.
- Symbol skew introduction by Retimer.

Example of XAUI Interconnect





Comparison of the HS I/O and XAUI Interface

Item	PECL	XAUI	Proposed XAUI
Transmitter			
Vo Diff$(max)_{p-p}$	2000 mV	800 mV	1600 mV
Vo Dif$(min)_{p-p}$	1200 mV	500 mV	900 mV
Voh	AC	AC	AC
Vol	AC	AC	AC
Iout nominal	16 mA	6.5 mA	12.5 mA
Receiver			
Vin (max)	2000 mV	1000 mV	1600 mV
Vin (min)	200 mV	175 mV	200 mV
Loss 50Ω	15.56 dB	9.1 dB	13 dB

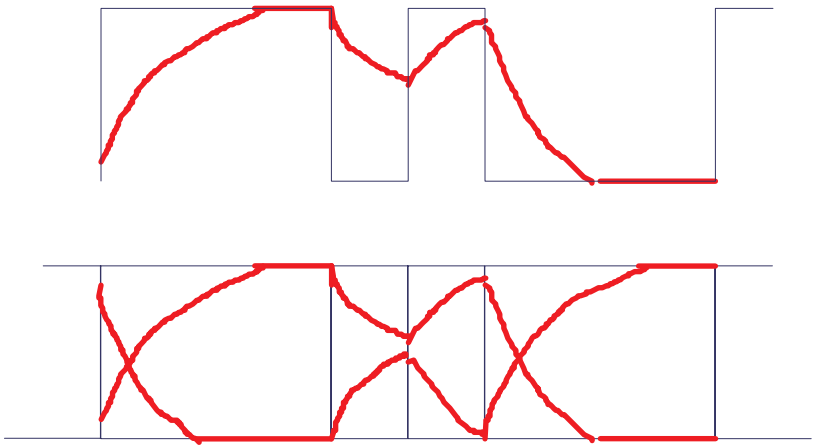
XAUI/Hari Loss Budget

Baud Rate	2.12 Gb/s	XAUI-3.125 Gb/s	**XAUI-3.125 Gb/s**
2 Connector Loss (dB)	1	1	**2**
Next+Fext Loss (dB)	0.75	0.75	**~2[1]**
PCB Loss ISI (dB)	7.35	7.35	**4.25 [2]**
PCB Loss LF (dB)	N/A	N/A	**2.75**
Link Margin (dB)	N/A	N/A	**2**
Loss Budget (dB)	9.1	9.1	**13**
PCB Condition [3]	Normal-High	Normal-High	**Normal-High**
MSTL Loss Max	0.22	0.32	**0.32**
Max Distance (in)	33.4	23	**21.9**
PCB Condition	Normal-High	Normal-High	**Normal-High**
STL Loss Max (dB)/in	0.29	0.41	**0.41**
Max Distance (in)	25.3	18	**17**

1. Fext/Next penalty dependent on the transmitt amplitude.
2. ISI loss of 4.25 dB does not require pre-emphasis will meet about 18.9 " of FR4.
3. PCB loss assume 5 mil trace with 1 Oz copper.

What is ISI

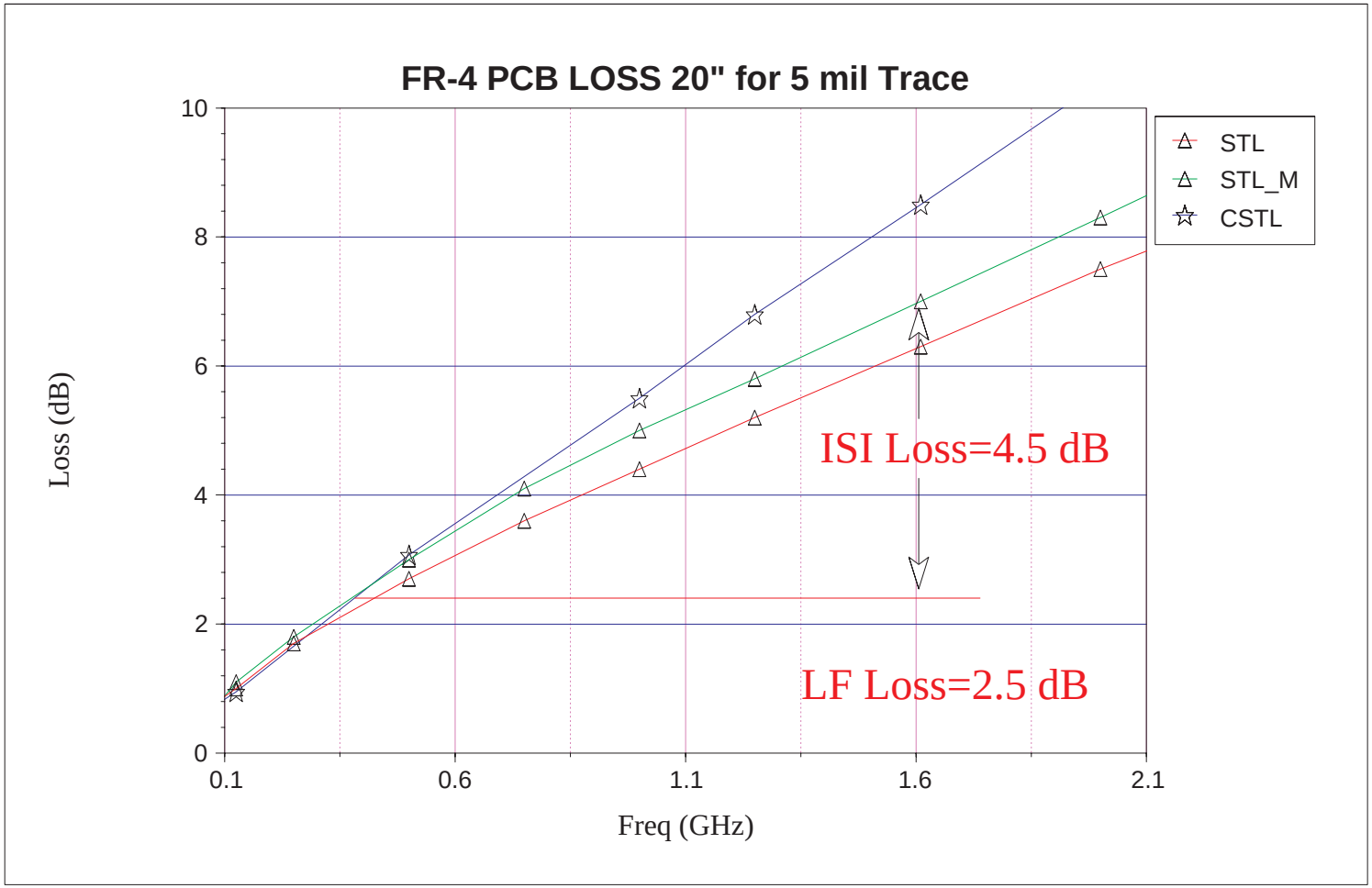
- ISI results from amplitdue losses between low and high frequency, 312.5 MHz to 1563 MHz.
- A 100% close eye has an ISI of 6 dB.



- ISI for given eye can be calculated as:

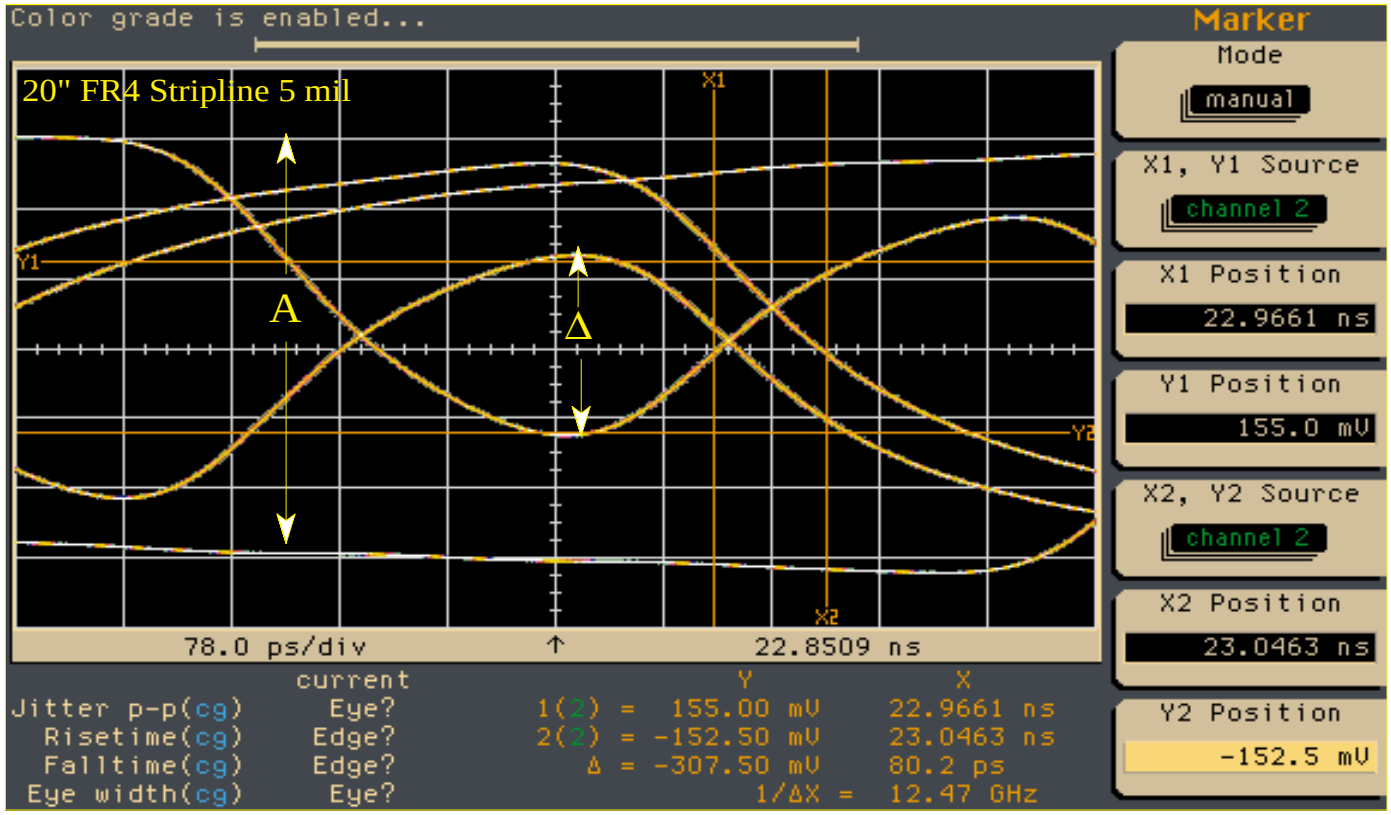
$$\text{ISI (dB)} = 20\ \text{Log}\left(\frac{A + \Delta}{2A}\right)$$

ISI and LF Losses



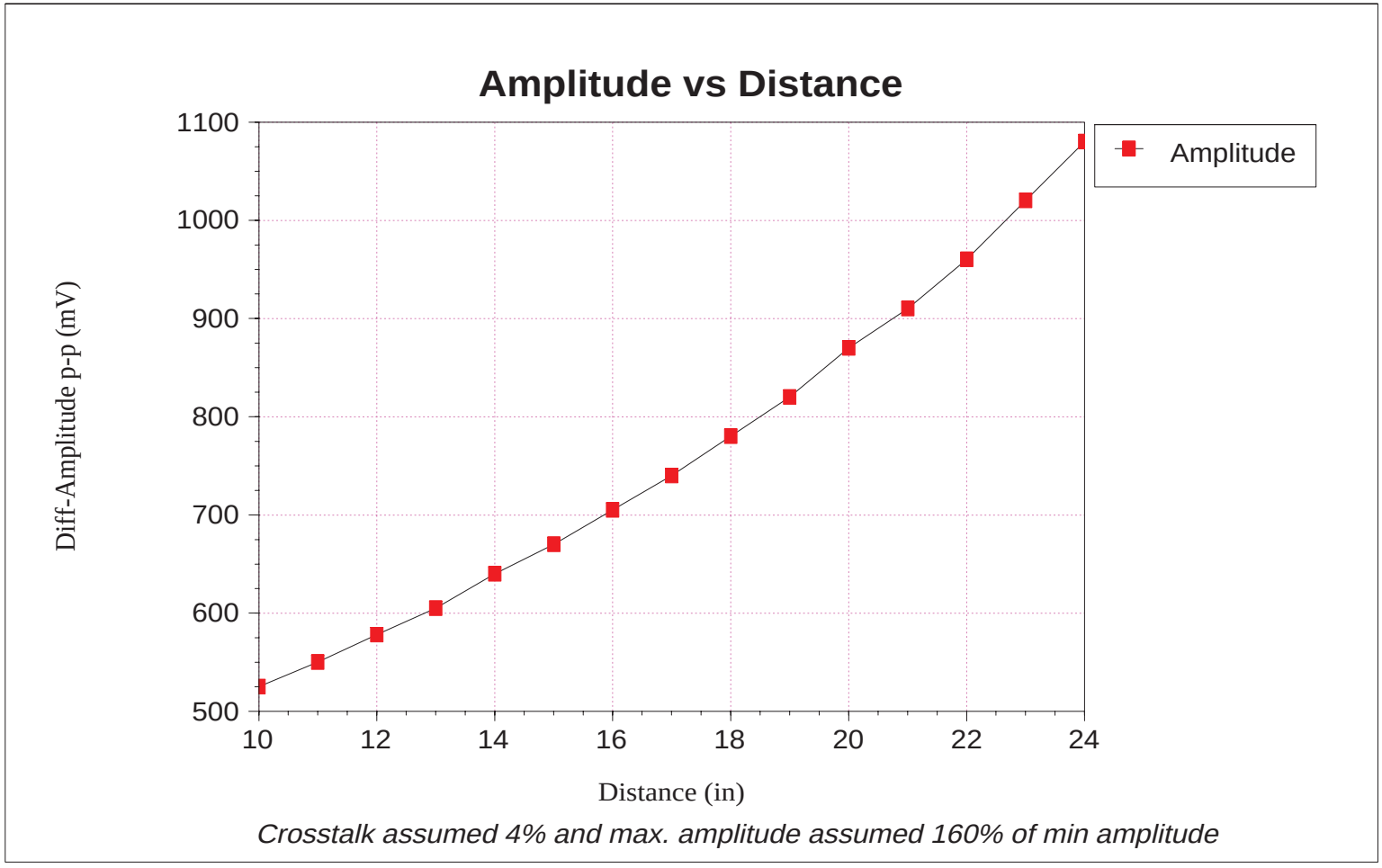
To limit the amplitude A we will choose ISI Loss=4.25 dB and LF Loss of 2.75 dB.
CSTL is the data from the Nov. 1999 presentation for a 5 mil coupled stripe line 0.5 oz.

Example Eye Diagram of a 5 Mil 20" Stripline



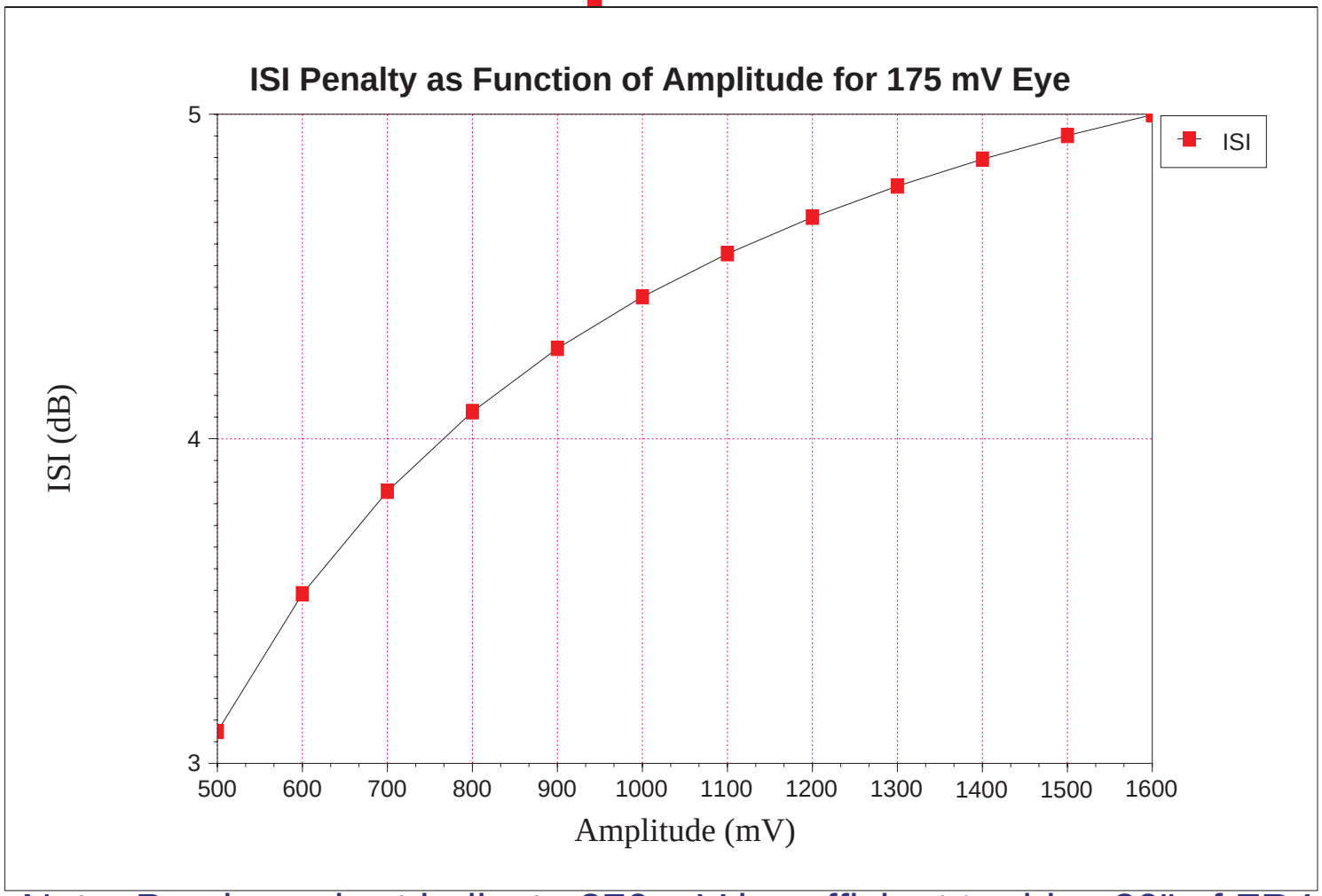
ISI for a given Eye Diagrm can be calculated as:
ISI Penalty = 20 Log((A + Δ)/2A) A= Amplitude p-p and Δ= Eye Opening
Above Example A= 800 mV and Δ=307 mV Then ISI = 3.2 dB.

Amplitude Required vs PCB Distance



Amplitude requirement incorporate 2 connectors (2dB), Stripline with Loss of 0.35 dB/in, 2 dB margin, and 4% crosstalk.

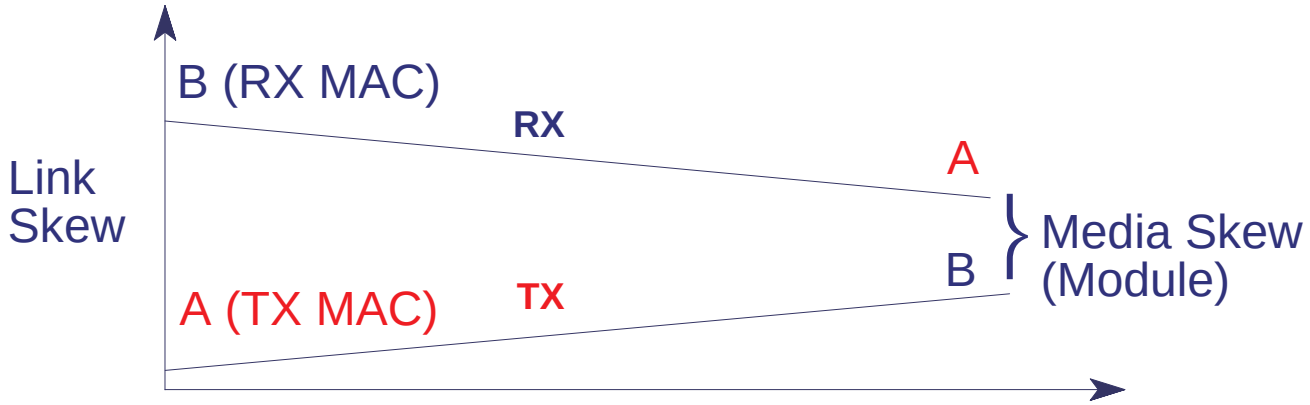
ISI Penalty as Function of Amplitude



Note: Previous chart indicate 870 mV is sufficient to drive 20" of FR4 but 4.25 dB of ISI loss requires 900 mV.

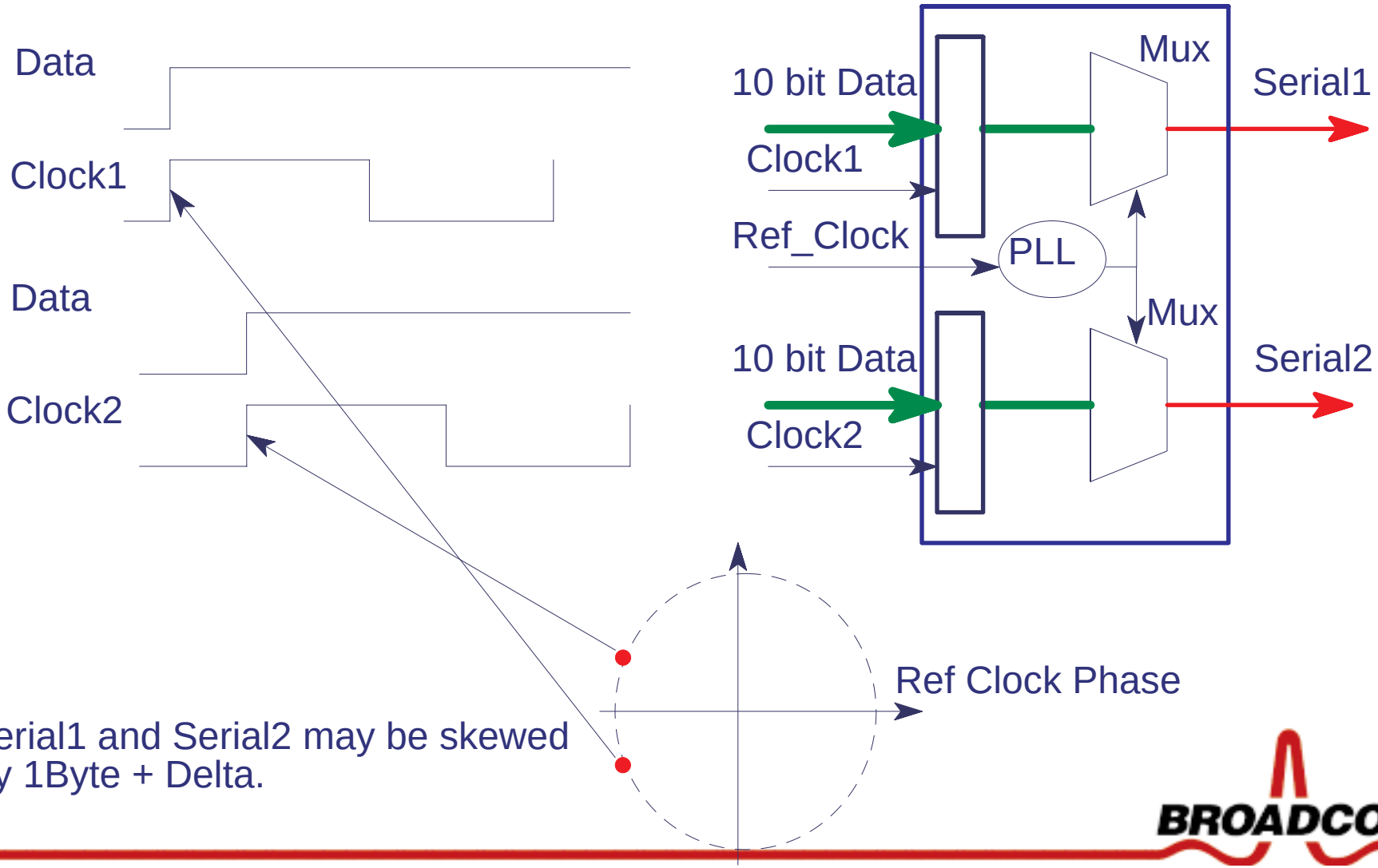
XAUI Link Skew Propagation

- XAUI link intention were for the skew to add and propagate from TX to RX:



- All serial solution you would need to de-skew.

Symbol Skew on SerDes Transmitter is Possible



Serial1 and Serial2 may be skewed
By 1Byte + Delta.

Retimers may Introduce Symbol Level Skew

- Some retimers implementation may advertently add symbol level skew due to race condition .
- One of the possible implementation to avoid extra skew is to first de-skew all the lanes.
- We should evaluate trade off between more flexible retimer designs vs limiting total skew.

Current XAUI Skew Budget and Additional Possible Skew

Hari Skew for	Current XAUI	XAUI
TX ASIC / SerDes	1UI	11
TX PCB	1 UI	1
TX Retimer	?	10*
Media Skew	16 UI	16
RX Retimer	?	10*
RX PCB	1 UI	1
SerDes RX/ASIC	20 UI	21
Total Link Skew (UI)	39	70
Total Link Skew (ns)	12.48	22.4

Notes: *Retimer symbol level skew can be avoided with the right implementation.

New proposal allocates 2 UI of skew as a result of electrical imperfection on the transmit and receive.

Current XAUI SerDes RX has 20 bits of logical skew without any electrical skew allocation.

Conclusions

- Up to 20" of FR4 without pre-emphasis meets the IEEE objective. Pre-emphasis difficult to specify and comply.
- For robust standard we need to consider:
  - ⇨ Next/Fext loss ~2 dB, Connectors 2 dB
  - ⇨ Link Margin ~ 2dB, PCB Loss 7 dB.
  - ⇨ Propose to change the minimum transmit amplitude to 900 mV for reliable 20" PCB interconnect.
- SerDes transmitter or a retimer may cause a symbol (10UI) skew.
- SerDes or retimer may introduce symbol skew an option is to allocate more skew.

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