06-206r1 SAS-2 iPASS™ Data Eyes vs. De-Emphasis

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Outline

Address the Concern that Fixed De-Emphasis on External Links Will Cause too much Jitter for Short Links
  • Compare Fixed and Optimal De-Emphasis for Example External SAS-2 Links
  • Estimate the Jitter Penalty of Fixed vs. Adaptive De-Emphasis

Discuss Concerns with Optional Adaptive De-Emphasis Provisions

Propose Recommendations for Discussion
Simulation Methodology

- Convert S-Parameters to Frequency Response
  - Use Mellitz Capacitive Package Model RL~7dB @ 3GHz
    \[ H(f) = \frac{S_{21} \Gamma_L + S_{12}}{(1 - S_{22} \Gamma_L) + S_{11} (1 - S_{22} \Gamma_L) + S_{21} \Gamma_L S_{12}} \]

- Convert Frequency Response to an Impulse Response
  \[ h(t) = \text{FFT}^{-1}(H(f)) \]

- Measure Transmitted Pulse Shape

- Compute the Optimal (ZF) De-Emphasis Tap Weights
  \[ y(t) = p(t) * h(t) \]
  \[ C_{zf} = \begin{bmatrix} y(\tau) & y(\tau - T) \\ y(\tau + T) & y(\tau) \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} \]

- Filter the Measured & Estimated Channel Output with the De-Emphasis Filter
  \[ \hat{y}_m(t) = y_m(t) * c(t) \quad \hat{y}(t) = x(t) * h(t) * c(t) \]

- Estimate the Jitter from the Data Eye \( \{ \hat{y}_m(t), \hat{y}(t) \} \)

- Compare to Measured Results
Computed Optimal and Laboratory Optimization De-Emphasis

De-Emphasis vs Cable Length

Theoretical

Measured

Limited by 9.9dB Max DE

6dB Max for EMI?
Optimal De-Emphasis iPASS Cables

Simulation vs Measured
- 6 Gbps Output Driver Test Chip
  - 2 Tap De-Emphasis
  - $0 \rightarrow 9.9$ dB De-Emphasis Capability

Optimal De-Emphasis vs Length iPASS Cables

Optimal De-Emphasis Simulated Eyes

Optimal De-Emphasis Measured Eyes

Non-Optimal DE 9.9dB Limit
Fixed 6dB De-Emphasis

Simulation vs Measured
- 6 Gbps Output Driver Test Chip
- 2 Tap De-Emphasis
- 0 → 9.9 dB De-Emphasis Capability

Optimal De-Emphasis vs Length iPASS Cables

6dB De-Emphasis Simulated Eyes

6dB De-Emphasis Measured Eyes

• 6 Gbps Output Driver Test Chip
• 2 Tap De-Emphasis
• 0 → 9.9 dB De-Emphasis Capability
Jitter vs Length with Fixed and Optimal De-Emphasis

- Measurement is 2000 hit Histogram

Minimum Length External Channel 0.5m Jitter is Simulated Only

Jitter Penalty at 10m is higher than at 1m length
Concerns on Adaptive DE

 Specification Concern:

- RE: T10/05-397r2 including IncEmp/Declmp,Done & NAK
- Otherwise We Fully Support T10/05-397r2

The data to date does not support the need for adaptive Tx De-Emphasis. 6dB of Fixed Tx De-Emphasis for external links does not appear to cause too much jitter when the short links are used.

The existing methods for optimizing Tx De-Emphasis in SAS-1 links can be used in SAS-2.

My concern is that we add a requirement/option which is not proven to be needed; furthermore, if it is added as an "optional" feature it most likely will become required under the following scenario.

- Marketing may view omission of an optional feature as being non-competitive, thus it will become a design team requirement for one design team, once this happens all phy solution will implement this feature and thus an "optional feature" will become a de facto requirement.
Technical Concern:

- Adding unnecessary complexity to all phy and the technical risk of completing adaptive equalizer training in the allocated time.

If this feature is added:

- The adaptive receiver will need the ability to decide how to control the Tx De-Emphasis. Most likely it will measure some channel metric (BER, Q, eye-opening...) and request changes to the Tx De-Emphasis to optimize the link.
- We will need budget time for decision process, Tx DE adjust time response....
- Would require supporting analysis and specification on response time, de-emphasis step sizes...

If STA/OEMs want this new capability, we can address the technical cost, complexity of potential implementations and how it would effect the speed negotiation timeline.
Optimal and Fixed De-Emphasis for External Links has been Investigated

- Simulated and Measured Results Match Well
- Fixed 6dB De-Emphasis Does not Cause Excessive Jitter for Short Links

Recommendations

- Do not define “optional” primitives for adaptive De-Emphasis in the Training Sequence unless technical need determined.
- Do Provide Adjustable De-Emphasis for Internal Links.
- Do Assume a Maximum of 6dB De-Emphasis for Link Analysis and Specification.
- Determine a Compliance Test Methodology for External Links.