

# VITESSE

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

Kevin Witt & Adrian Robinson

SAS-2 Phy Working Group

5/1/06



YOUR PARTNER FOR SUCCESS

## 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

## Convert S-Parameters to Frequency Response

- Use Mellitz Capacitive Package Model RL~7dB @ 3GHz

$$H(f) = \frac{S_{21}\Gamma_L + S_{21}}{(1 - S_{22}\Gamma_L) + S_{11}(1 - S_{22}\Gamma_L) + S_{21}\Gamma_L S_{12}}$$

## Convert Frequency Response to an Impulse Response

$$h(t) = FFT^{-1}(H(f))$$

## Measure Transmitted Pulse Shape

## Compute the Optimal (ZF) De-Emphasis Tap Weights

$$y(t) = p(t) * h(t)$$

$$C_{zf} = \begin{bmatrix} y(\tau) & y(\tau - T) \\ y(\tau + T) & y(\tau) \end{bmatrix}^{-1} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

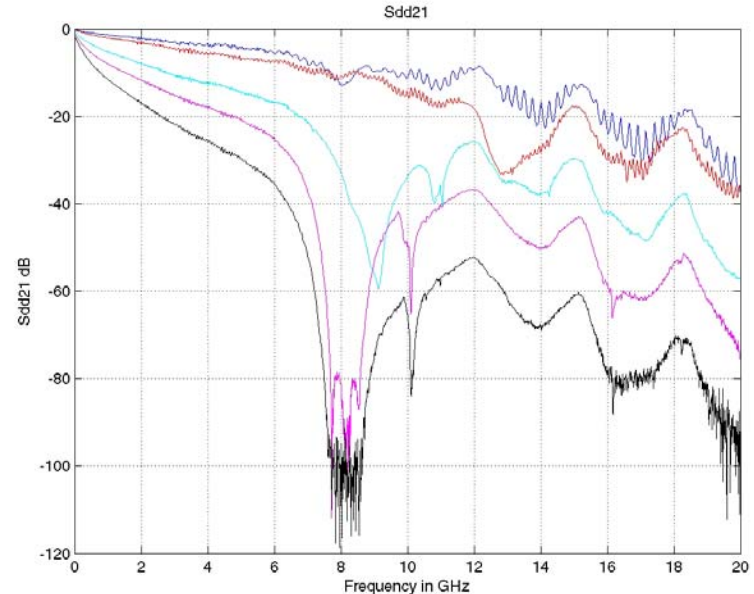
## Filter the Measured & Estimated Channel Output with the De-Emphasis Filter

$$\hat{y}_m(t) = y_m(t) * c(t) \quad \hat{y}(t) = x(t) * h(t) * c(t)$$

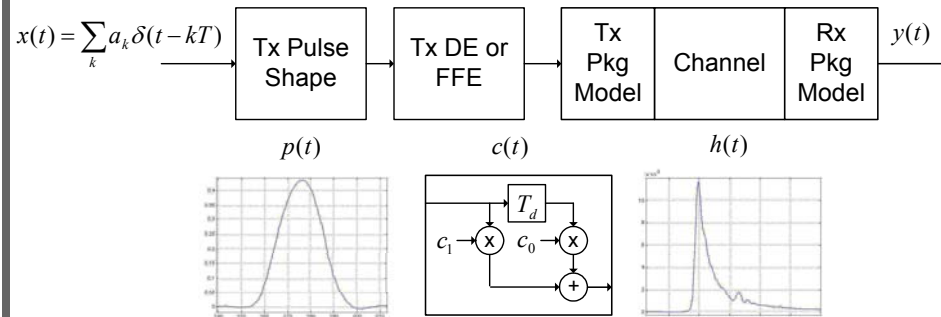
## Estimate the Jitter from the Data Eye $\{\hat{y}_m(t), \hat{y}(t)\}$

## Compare to Measured Results

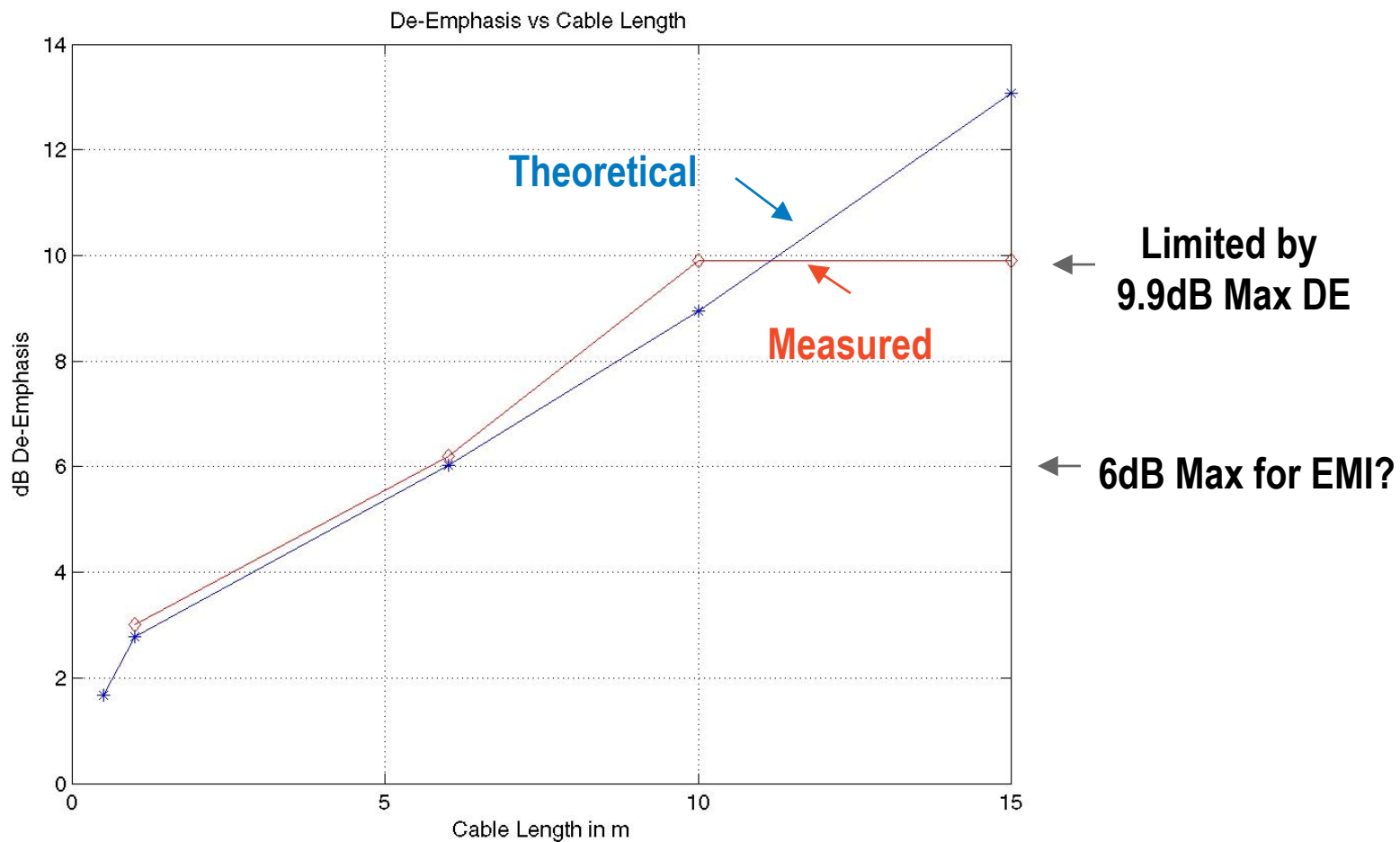
0.5, 1, 6, 10 & 15m iPASS



Simulation Model



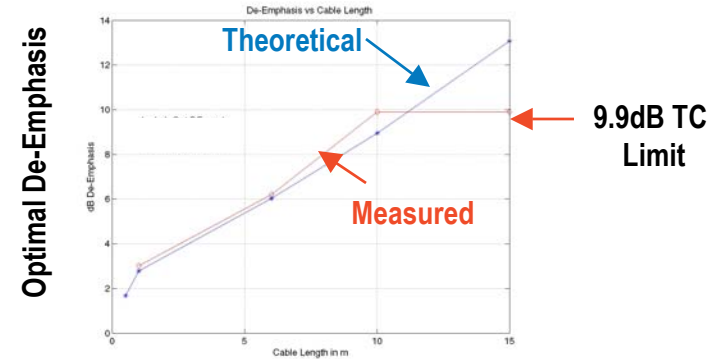
## 📖 Computed Optimal and Laboratory Optimization De-Emphasis



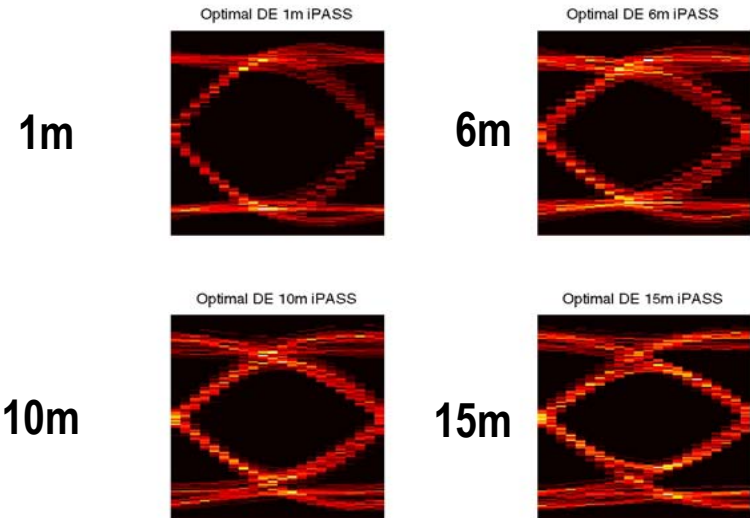
## Simulation vs Measured

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

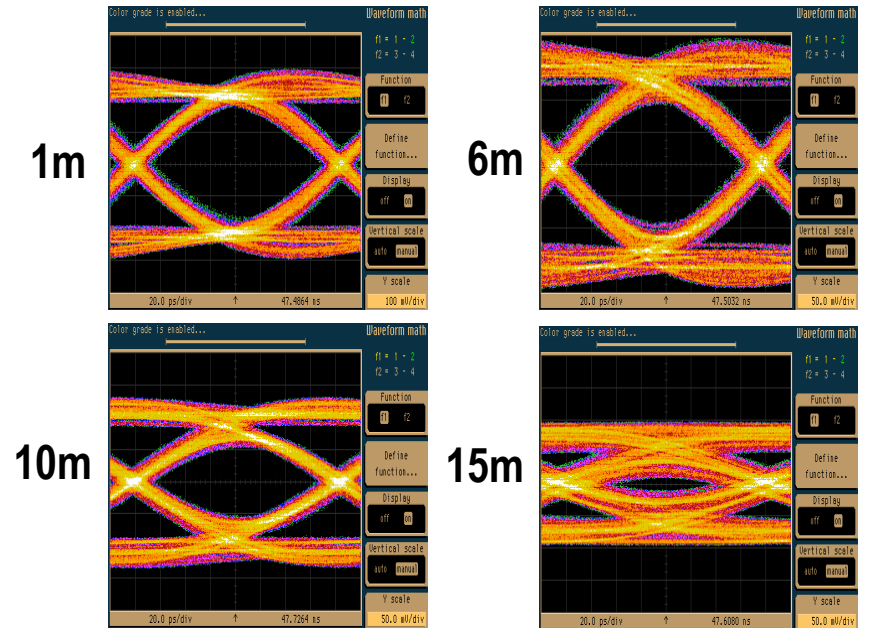
## Optimal De-Emphasis vs Length iPASS Cables



## Optimal De-Emphasis Simulated Eyes



## Optimal De-Emphasis Measured Eyes



Non-Optimal DE 9.9dB Limit

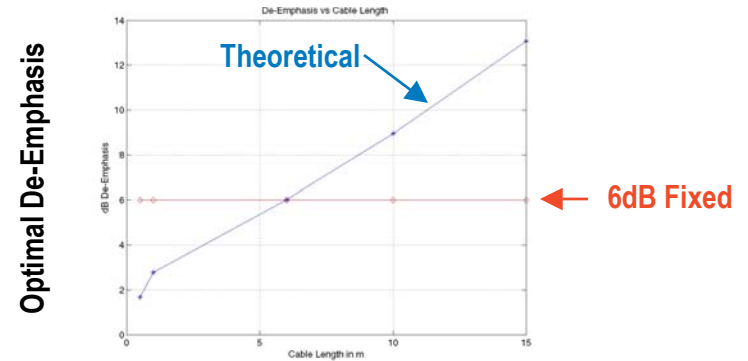
# Fixed 6dB De-Emphasis

VITESSE

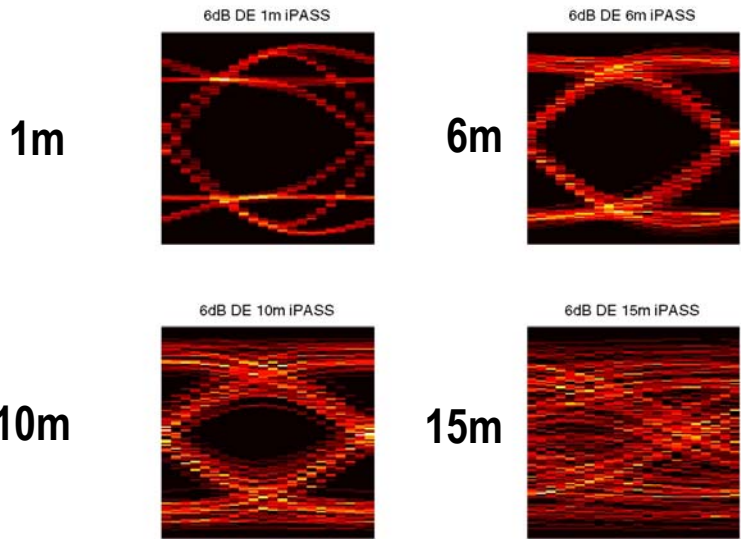
## Simulation vs Measured

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

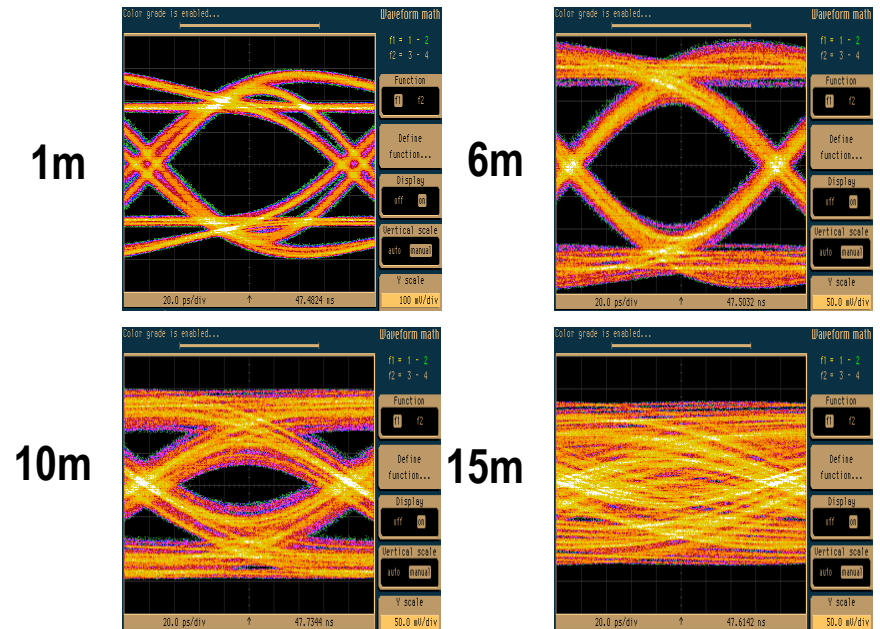
## Optimal De-Emphasis vs Length iPASS Cables



## 6dB De-Emphasis Simulated Eyes

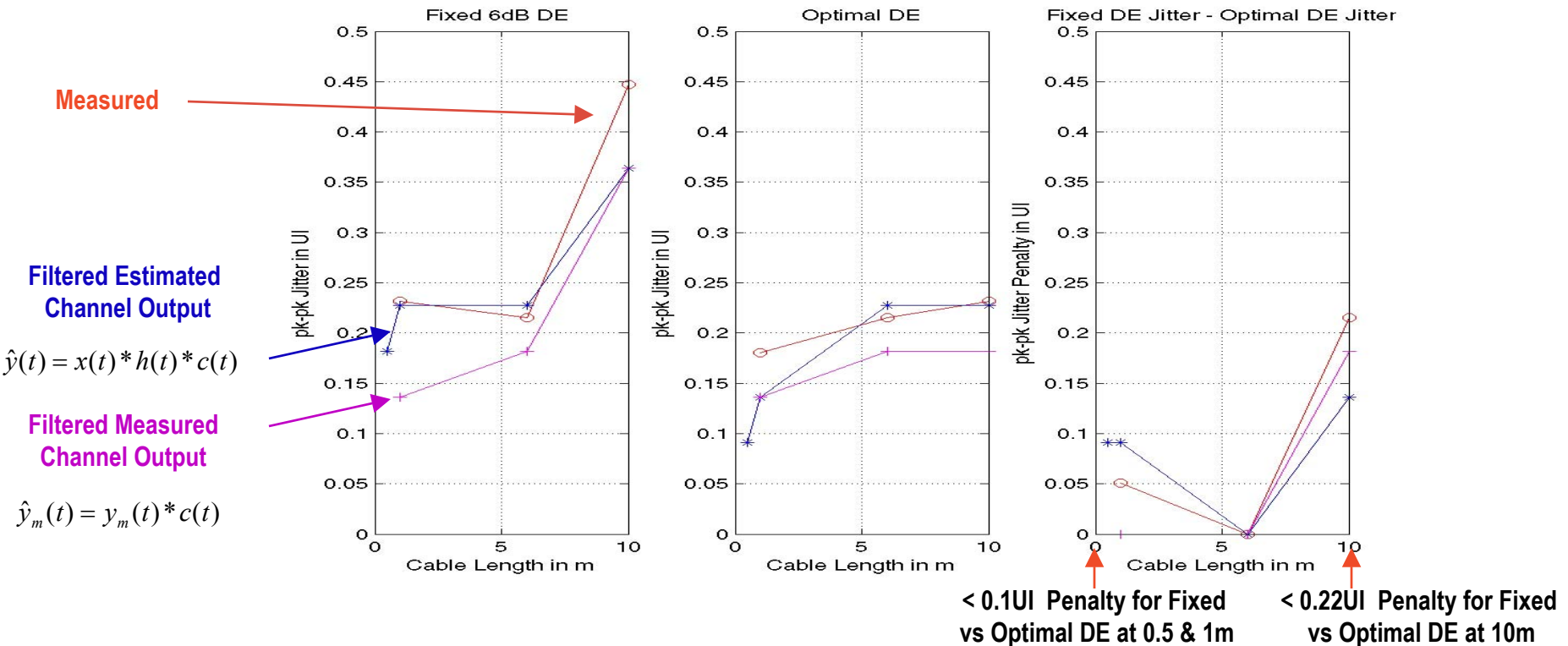


## 6dB De-Emphasis Measured Eyes



## 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

## **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 defacto 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 Specify a Fixed 6dB Fixed De-Emphasis for External Links.
- 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.