

# SAS 6 Gbps Proposal Based on OIF CEI 6G

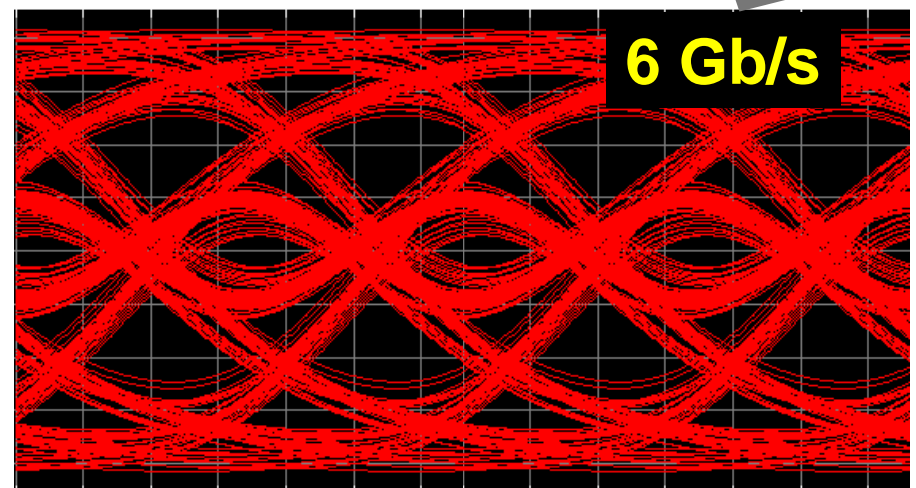
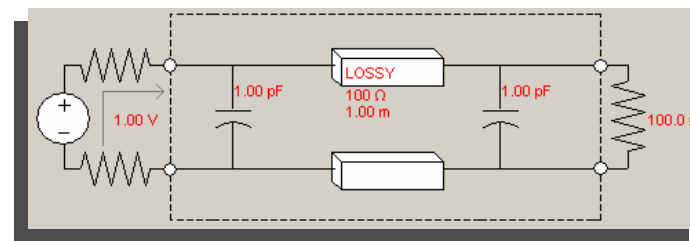
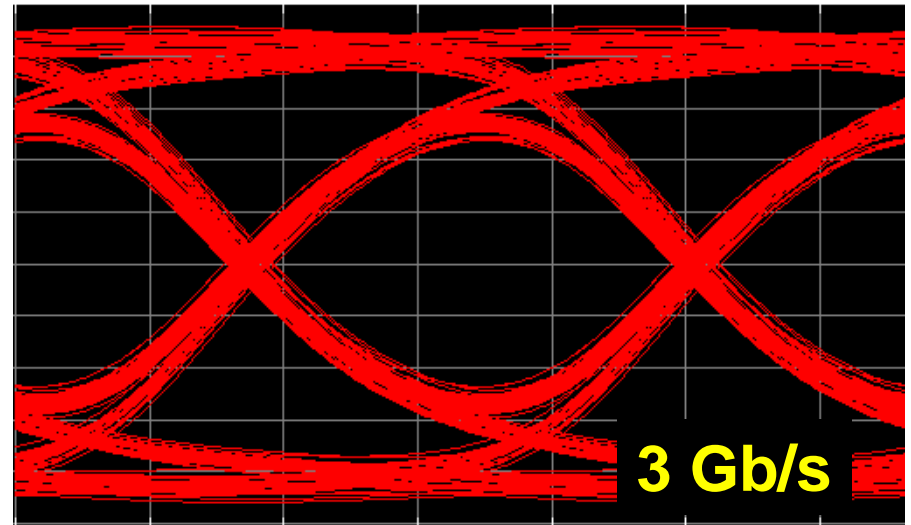
Mike Jenkins

Joe Caroselli

LSI Logic Corp.

Q: Why not simply adjust the 3Gb/s spec values to create the 6Gb/s specification?

A: Because the virtually closed eye at 6G requires a fundamentally different approach



# Objectives


- To propose a framework based on the structure of the OIF CEI
- To begin to identify elements common between OIF CEI and SAS 1.0
- To begin to identify elements *not* common
  - To justify these differences as desirable or necessary due to the higher speed

# Introduction (1 of 3)

- Where it's going: OIF CEI is becoming the basis for a number of standards
- Where it's from: OIF CEI appears to have evolved from a number of existing standards
  - As witness, the snippet of OIF CEI “genetic code” to the right obviously came from Fibre Channel or SAS

Implementation Agreement OIF-CEI-02.0 Common Electrical I/O (CEI)

---



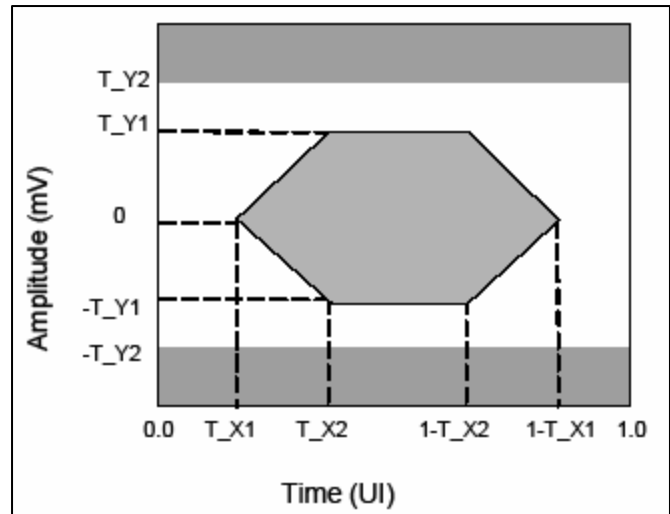
## OIF

OPTICAL  
INTERNETWORKING  
FORUM

IA Title : Common Electrical I/O (CEI) -  
Electrical and Jitter Interoperability  
agreements for 6G+ bps and 11G+ bps I/O

IA # OIF-CEI-02.0

28th February 2005



# Introduction (2 of 3)

OIF CEI 2.0 has an impressive (to me anyway) collection of theoretical and practical appendices

2.A	Masks	46
2.A.1	Total Wander Mask	46
2.A.2	Relative Wander Mask	46
2.A.3	Random Jitter Mask	47
2.B	Pulse Response Channel Modelling	48
2.B.1	Generating a Pulse Response	48
2.B.2	Basic Pulse Response Definitions	49
2.B.3	Transmitter Pulse Definition	50
2.B.4	Receiver Pulse Response	51
2.B.5	Crosstalk Pulse Response	52
2.B.6	Decision Feedback Equalizer	52
2.B.7	Time Continuous Transverse Filter	53
2.B.7.1	Annex - Time Continuous Zero-Pole Equalizer adaption	53
2.B.8	Time Continuous Zero/Pole	53
2.B.9	Degrees of Freedom	54
2.B.9.1	Receiver Sample Point	54
2.B.9.2	Transmit Emphasis	54
2.C	Jitter Modelling	55
2.C.1	High Frequency Jitter vs. Wander	55
2.C.2	Total Wander vs. Relative Wander	55
2.C.3	Correlated vs. Uncorrelated Jitter	56
2.C.4	Jitter Distributions	57
2.C.4.1	Unbounded and Bounded Gaussian Distribution	57
2.C.4.2	Bounded Gaussian Distribution	58
2.C.4.3	High Probability Jitter	58
2.C.4.4	Total Jitter	58
2.C.4.5	Probability Distribution Function vs. Cumulative Distribution Function	59
2.C.4.6	BathTub	60
2.C.4.7	Specification of GJ and HPJ	62
2.C.4.8	Example of Bounded Gaussian	62
2.C.5	Statistical Eye Methodology	63
2.C.5.1	Derivation of Cursors and Calculation of PDF	63
2.C.5.2	Inclusion of Sampling Jitter	66
2.C.5.3	Generation of Statistical Eye	68
2.D	Lab Setups	70
2.D.1	High Frequency Transmit Jitter Measurement	70
2.D.1.1	BERT Implementation	70
2.D.1.2	Spectrum analyzer and Oscilloscope Methodology	71
2.D.2	Total Transmit Wander Measurement	74
2.D.3	Relative Transmit Wander Measurement	75
2.D.4	Jitter Tolerance	76
2.D.4.1	Jitter Tolerance with Relative Wander Lab Setup	76
2.D.4.2	Jitter Tolerance with no Relative Wander Lab Setup	78
2.D.4.3	Jitter Tolerance with Defined ISI and no Relative Wander	79
2.D.5	Jitter Transfer	79
2.D.6	Network Analysis Measurement	80
2.D.7	Eye Mask Measurement Setup	82
2.E	BER Adjustment Methodology	83
2.E.1	Extrapolation of Correlated Bounded Gaussian Jitter to low BERs	83
2.E.2	Confidence Level of Errors Measurement	83
2.E.3	Eye Mask Adjustment for Sampling Oscilloscopes	84
2.E.3.1	Theory	85
2.E.3.2	Usage	87

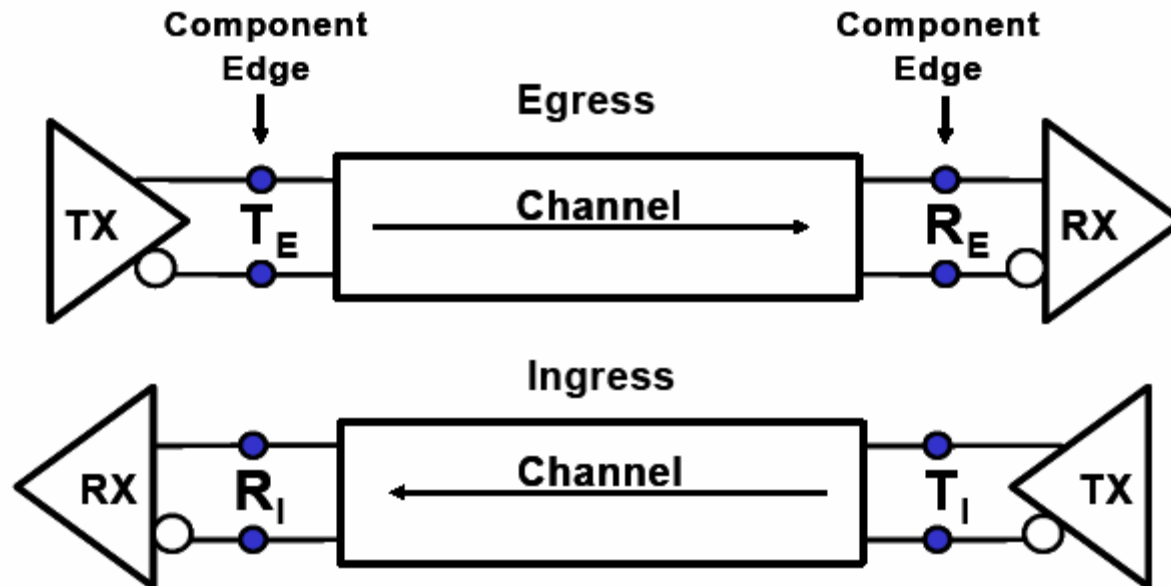
3.A	Transmission Line Theory and Channel Information	94
3.A.1	Transmission Lines Theory	94
3.A.1.1	Impedance Matching	94
3.A.1.2	Impedance Definition Details	95
3.A.2	Density considerations	97
3.A.3	Common-Mode Impedance and Return Loss	98
3.A.4	Crosstalk Considerations	98
3.A.5	Equation based Channel Loss by curve fit	100

# Introduction (3 of 3)

- OIF CEI 6G-SR (short reach) is a chip-to-chip spec which is insufficient for 6G SAS (up to 8")
- OIF CEI 6G-LR (long reach) is meant to include legacy backplanes (up to 1 meter)
  - Requires 5-tap DFE in reference RX
- This proposal will be a framework compromising between these two specs
  - All values are, of course, TBD

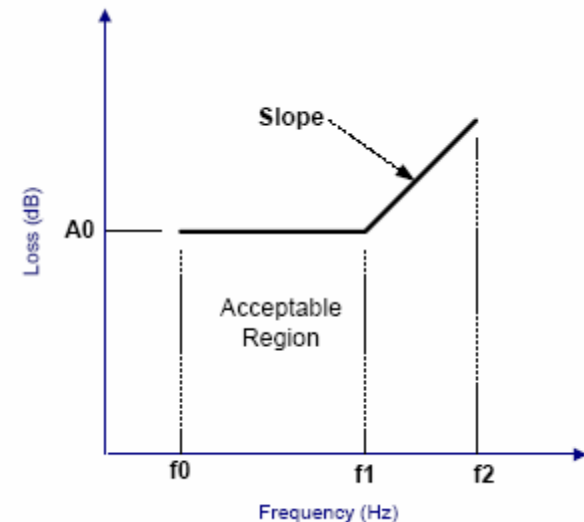
# OIF CEI Reference Model

- Ingress/Egress distinction may be useful in specifying SAS ↔ SATA links
- “Component Edge” will likely be equated to “Separable Connector”



# Transmitter

- 800-1200 mVppd (?)
- 1 tap (at least) of emphasis
  - Pre- or post-cursor
- Return Loss (SDD11):
  - “The differential return loss shall be better than  $A_0$  from  $f_0$  to  $f_1$  and better than  $A_0 + \text{Slope} \cdot \log_{10}(f/f_1)$  where  $f$  is the frequency from  $f_1$  to  $f_2$ .”
- Compliant TX: required eye after reference channel + reference RX





# Receiver

- Return Loss (SDD11):
  - “The differential return loss shall be better than  $A_0$  from  $f_0$  to  $f_1$  and better than  $A_0 + \text{Slope} \cdot \log_{10}(f/f_1)$  where  $f$  is the frequency from  $f_1$  to  $f_2$ . ”
- Compliant RX: required eye after reference TX + reference channel
- “Reference receiver” offers an architecture known to work... *but CEI does not require use of that architecture.*

# Some CEI-vs-SAS Issues (1 of 2)

- No framework for OOB specs
  - If OOB data rate does not increase, can keep same/similar electrical specs as SAS1
- Presently, no consideration for 8B10B coding in simulators (including StatEye)
  - Causes too-pessimistic eye closure
- Question about “worst case” RX return loss
  - Should it be minimum (vs. max) resistance?

# Some CEI-vs-SAS Issues (2 of 2)

- TX compliance should make use of TCTF (aka “compliance channel”)
  - Allows testing specific to cable or PCB
  - TCTF definition could be expanded to include NEXT & FEXT (near-end & far-end cross talk)
  - Avoids difficulties of near end TX measurements (resonance, fixture effects,...)

# Summary

- Methodology of OIF CEI fits the needs (mostly) of 6G SAS
  - Accommodates closed eyes at RX input
  - StatEye (publicly available) & similar proprietary tools support this methodology
- Likely need to interpolate 6G SAS spec between 6G-SR & 6G-LR (short & long reach)