What Are the Benefits of Open Eye?

Mark Kimber - Semtech

August 2020

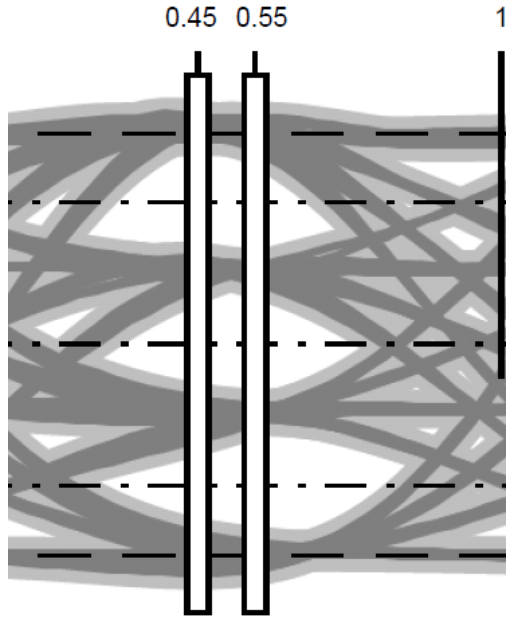
Philosophy of Open Eye Approach

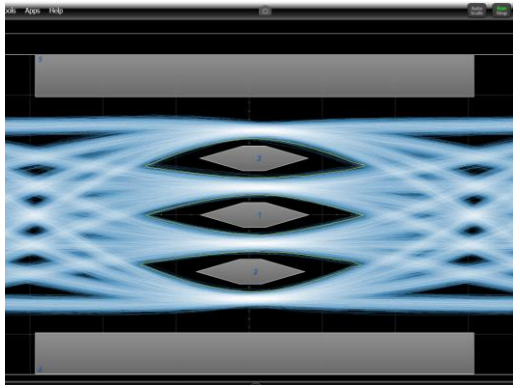
- Balance equalization between transmitter and receiver
  - Allow approximately equal impairments at the transmitter and receiver
  - Transmitter should deal with its impairments
  - Receiver deals with its impairments
- Decouple transmitter performance characterization from receiver
  - IEEE uses the receiver to equalize the transmitter before assessment
  - Transmitter depends on receiver performance
- Technology agnostic specification
  - IEEE TDECQ approach favors DSP
- Maintain IEEE link budgets
- Maintain IEEE transmitter power specifications
- Maintain VSR/CAUI electrical interfaces

TDECQ vs. Eye Opening

Eye Opening method reduces the complexity of test and measurement → lower manufacturing cost and improves inter-op

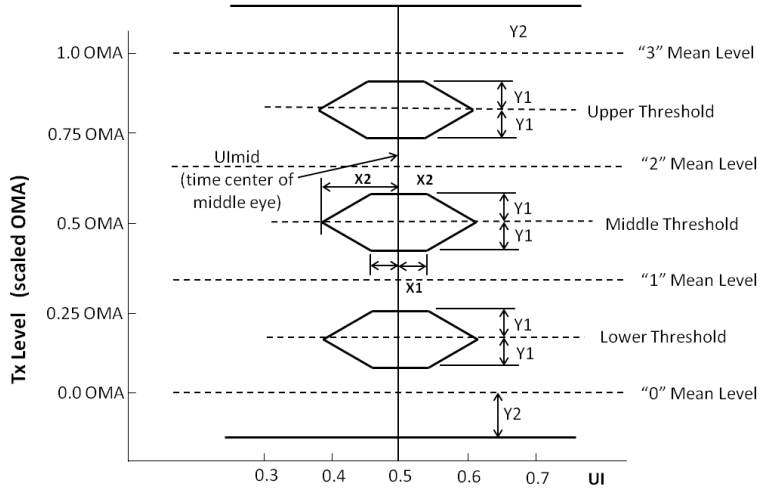
	Open Eye	IEEE
Equalization	• Performed at the transmitter • Eliminates the need for higher power DSP on the RX	• Relies on the RX equalizing the TX using a 5 tap, T-spaced equalizer • Favors DSP
Production Test	• Eye Mask Based combined with statistical techniques approach to transmitter vertical eye closure to estimate resulting receiver penalty. • More complete evaluation and screen of the transmitter • More deterministic assessment as no assumptions made about receiver equalization → better inter-op	• Reference Receiver Based • Requires complex reference receiver optimization during test • Can give a wide range of “equivalent” equalizations reducing test accuracy and resulting in ambiguity between reference receiver and actual receiver implementation → more inter-op issues
Independence of transmitters and Receivers	• Avoids dependence of transmitter on receiver capability • Minimizes undesirable interactions between linearity and group delay	• IEEE depends on the receiver to equalize the transmitter • Creates a dependency of transmitter performance on receiver capability
Technology Choices	• Analog and digital implementations • Allows easier adoption of new technologies for lower power	• Favors digital implementation • Requires use of signal processing

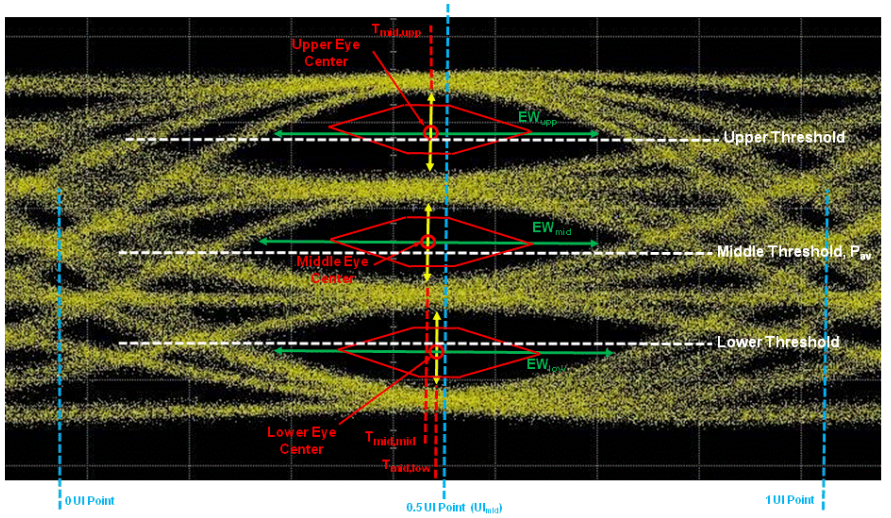




Other Open Eye Benefits

- Overshoot and undershoot controlled via mask test
  - Simple transmitter assessment
  - Controls fast and slow overshoot/undershoot
  - TDECQ does not control overshoot and undershoot for 50Gb/s PMDs
- Eye center position of transmitter is controlled
  - TDECQ does not control eye position
  - Can stress clock recovery if too extreme
- Eye skew is controlled
  - TDECQ does not control transmitter eye skew directly





200G-FR4 SM Open Eye Key Specifications

- Optimizing specification to enable implementation using a wide range of optical and electronics technologies
  - Low cost silicon photonics or widely available EML/DML
  - Low power and low latency electronics
- Compatible with installed single mode fiber infrastructure and CWDM4 optical grid
- Compatible with 53Gbit PAM-4 host requirements
  - OIF CEI-56G-VSR-PAM4
  - IEEE 50GAUI-1, 100GAUI-2, 200GAUI-4, 400GAUI-8
- Enables low power SFF modules
- TX and RX tradeoffs optimized for lowest power

SMF Power budget	
Operating distance	2km
Channel insertion loss	4dB
Wavelengths	1271nm 1291nm 1311nm 1331nm

50G per lane SRx-MM Open Eye Key Specifications

- Optimizing specification to enable implementation using a wide range of optical and electronics technologies
  - Low cost VCSELs
  - Low power and low latency electronics
- Compatible with installed multimode fiber infrastructure
- Compatible with 53Gbit PAM-4 host requirements
  - OIF CEI-56G-VSR-PAM4
  - IEEE 50GAUI-1, 100GAUI-2, 200GAUI-4, 400GAUI-8
- Enables low power SFF modules
- TX and RX tradeoffs optimized for lowest power

MMF Power budget	
Operating distance	70m OM3 100m OM4 OM5
Channel insertion loss	1.8dB for OM3 1.9dB for OM4 OM5
Wavelength	840nm to 860nm

Coming soon: 50G-LR SM Open Eye Key Specifications

- Optimizing specification to enable implementation using a wide range of optical and electronics technologies
  - Low cost silicon photonics or widely available EML/DML
  - Low power and low latency electronics
- Compatible with installed single mode fiber infrastructure
- Compatible with 53Gbit PAM-4 host requirements
  - OIF CEI-56G-VSR-PAM4
  - IEEE 50GAUI-1
- Enables low power SFF modules
- TX and RX tradeoffs optimized for lowest power

SMF Power budget	
Operating distance	10km
Channel insertion loss	6.3dB
Wavelengths	1311nm

Benefits of Open Eye Solution

- **Key Benefits**
  - Enables implementation with wider range of analog and digital electronics technologies
  - Supports existing fiber plant and host interface
  - Lower cost than IEEE standard based optics
  - Lower power
  - Lower latency
  - Supports existing fiber plant and host interface

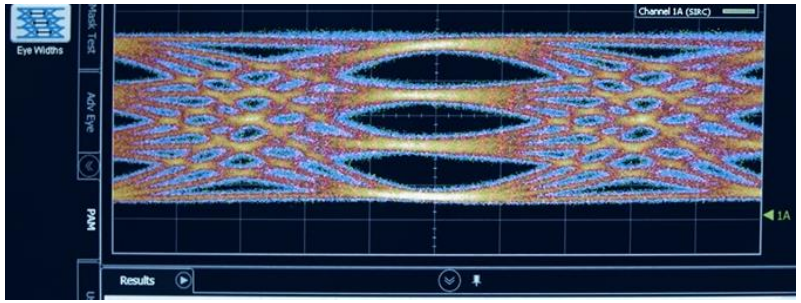
- **Why Industry Needs this MSA**

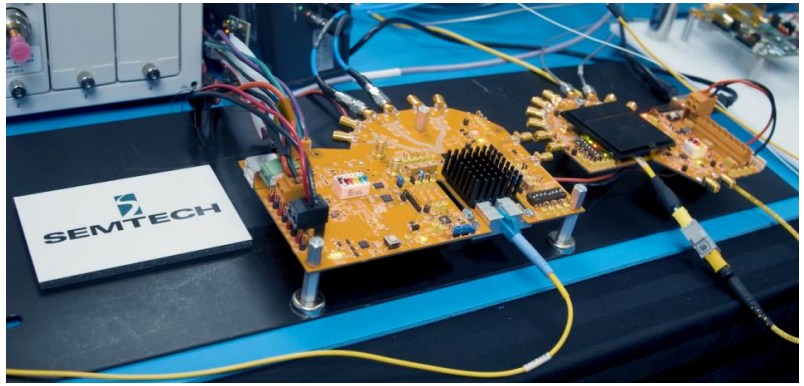
  Multiple optics, components and system companies focused on low cost are needed define an interoperability specification enabling multiple supply sources of all components

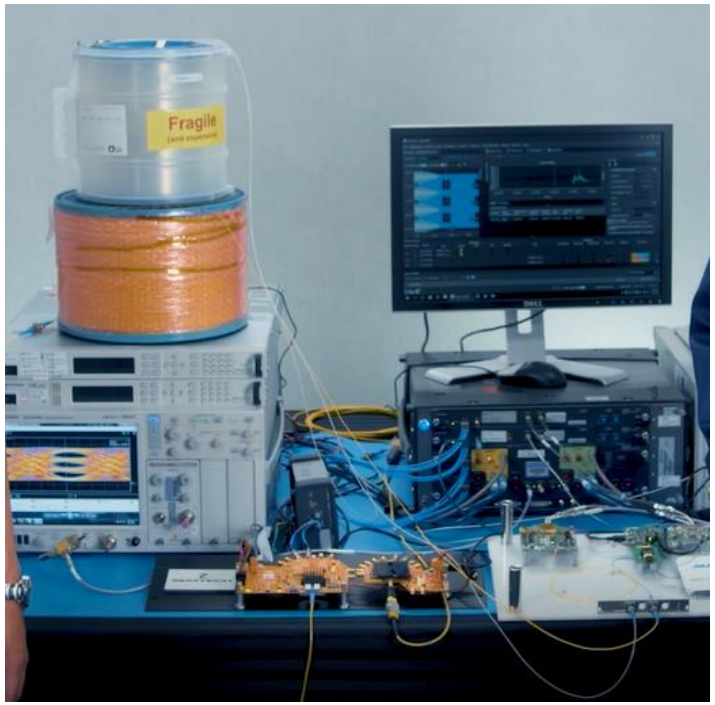
Multivendor Interoperability

Demonstrated 10km, 200Gbps link at 1E-8 Pre-FEC BER

SEMTECH







MACOM