PAM4 for 200G/L Optics at 500m and 2km

Brian Welch (Cisco Inc.)

Supporters

- Phil Sun – Credo Semiconductor
- Bharat Tailor – Semtech
- Frank Chang – Source Photonics
- Peter Stassar – Huawei
- Drew Guckenberger – Maxlinear
- Vipul Bhatt – II-VI
- Mark Kimber – Semtech
- Andy Bechtolsheim – Arista
- David Lewis – Lumentum
- Tom Palkert – Samtec
- John Johnson – Broadcom
- Rang-Chen Yu, SiFotonics
- Will Bliss - Broadcom
- Atul Srivasta – NEL-America
- Fadi Daou – Multilane Inc.
- Ali Ghiasi – Ghiasi Quantum/Marvell
- Pirooz Tooyserkani – Cisco
- Kohichi Tamura – CIG Tech
- Scott Schube – Intel
- Jianwei Mu – Hisense Broadband
- Eric Maniloff – Ciena
- Piers Dawe – Nvidia
- Arash Farhoodfar - Marvell

PAM4 for 200G/L Optics at 500m and 2km

- **Proposal**: Adopt PAM4 optical modulation as the basis for 200 Gb/s per lane 500m and 2km SMF reach objectives.

- **Motivations:**
  - We have unanimous support to this direction per the straw poll from 2/24/2022
  - Full baseline proposals likely to take some time to define, gated by PCS/FEC decisions.
    - i.e, Bit rate and BER requirements still TBD
  - Adopting a modulation format allows the task force's work to become more focused as we work towards a full baseline proposal:
    - It is a critical first step to enable (intensive) serdes and component design for optical I/O – Baselines not needed until later

Straw Poll Results

2/24/2022 https://www.ieee802.org/3/df/public/22_02/motions_3df_0222.pdf

Straw poll #4

- **Would you support PAM4 as the modulation type for 200G/L solutions at 500m and 2km reaches.**

Yes:	**80**
No:	**0**
Need more information:	**10**
Abstain:	**7**

Applicable objectives

Ethernet Rate	Assumed Signaling Rate	AUI	BP	Cu Cable	MMF 50m	MMF 100m	SMF 500m	SMF 2km	SMF 10km	SMF 40km
200 Gb/s	200 Gb/s	Over 1 lane		Over 1 pair			Over 1 Pair	Over 1 Pair		
400 Gb/s	200 Gb/s	Over 2 lanes		Over 2 pairs			Over 2 Pair			
800 Gb/s	100 Gb/s	Over 8 lanes	Over 8 lanes	Over 8 pairs	Over 8 pairs	Over 8 pairs	Over 8 pairs	Over 8 pairs		
	200 Gb/s	Over 4 lanes		Over 4 pairs			Over 4 pairs	1) Over 4 pairs 2) Over 4 λ's		
	TBD								Over single SMF in each direction	Over single SMF in each direction
1.6 Tb/s	100 Gb/s	Over 16 lanes								
	200 Gb/s	Over 8 lanes		Over 8 pairs			Over 8 pairs	Over 8 pairs		

Eight Objectives using 200G/L for 500m or 2km reaches

Supporting Materials

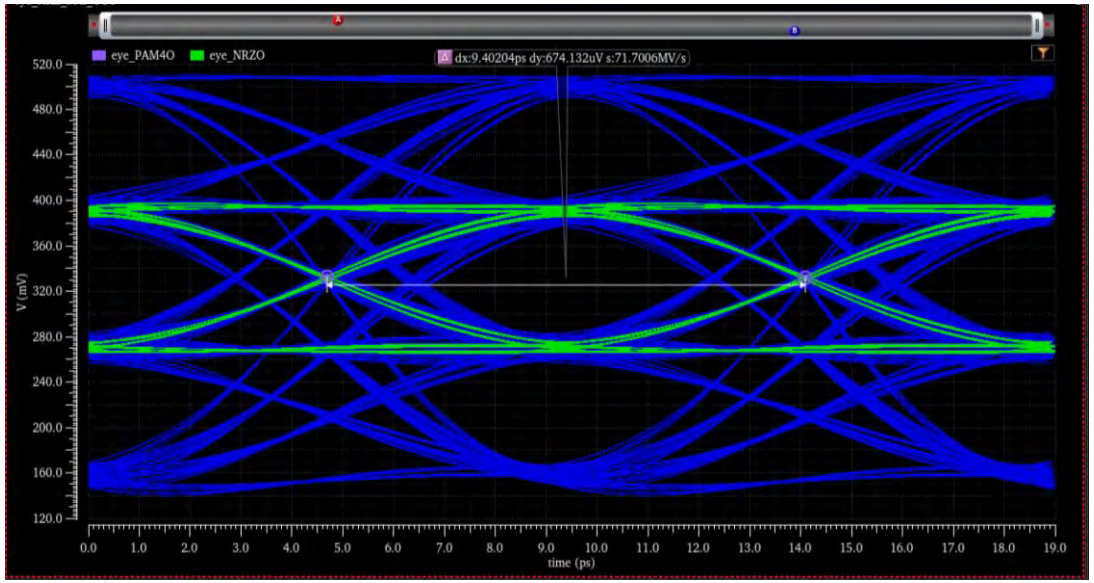
- **Optical Components**: Modulation proposal for 200G/L solutions for 500m and 2km reaches
  - https://www.ieee802.org/3/df/public/22_02/welch_3df_02a_220222.pdf

- **Optical Components**: On technical feasibility of optical 200 Gb/s PAM4
  - https://www.ieee802.org/3/df/public/22_02/kuschnerov_3df_01_220222.pdf

- **Serdes Design:** *A 1.41 pj/b 224GGb/s PAM-4 SerDes Receiver with 31dB Loss Compensation*, ISSCC 2022, Yoav Segal, Amir Laufer, et. al.

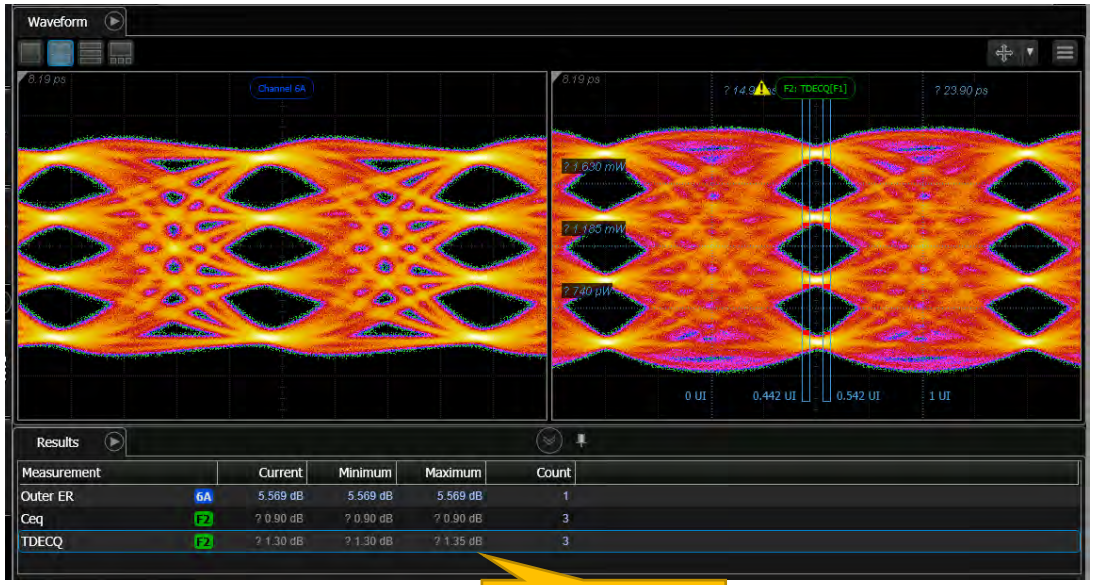
Continuing Development

Optical Transmitter – Welch_3df_02a_220222



Simulation Result

Optical Transmitter - Current



Simulation Result

TDECQ ~ 1.3 dB
REF EQ = FFE5

Proposed Motion:

Move to adopt PAM4 optical modulation as the basis for all the 200 Gb/s per lane 500m and 2km SMF reach objectives

- Yes:
- No:
- Abstain:

Thank You