Baseline Proposal for 100G Backplane Specification Using PAM2

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Introduction

- Dudek_01a_0112 made a proposal for a PAM2 (NRZ) specification for use on copper backplanes for 100G

- This is an update to that document including more channel specifications and changes based on the assumption of a 0% over-clocking FEC.

Introduction (cont)

- All test methodologies refer to 802.3ba unless stated otherwise.

- This specification is based on a channel loss budget of 30 dB at a signaling rate of 25.78125 GBd to meet a BER of 1e-12

- Optional FEC is incorporated to achieve higher losses of 35 dB (or reduce the BER to 1e-15or lower at somewhat less loss). The Rx will have to meet an uncorrected BER of approx 2e-5 with this 35dB channel with a worst case Tx.

- This proposal is not intended to compete with the test methodology ad-hoc being chaired by Charles Moore. The intent is to update this with the results from that group, when they have been agreed.

Tx proposal

- A 3 tap FIR filter is proposed. (Similar to 10GBASE-KR, CEI-25G-LR of OIF, and FC-PI-5 of FC)
  - OIF has determined that additional tap was not helpful for their 25.5dB channel
  - Need to evaluate if an additional pre-cursor tap is worthwhile for this higher loss channel
- Tx training using the same algorithm as 10GBASE-KR is proposed.
- This presentation uses the linear pulse fit methodology of 802.3ba subclause 85.8.3.3 to enable transmitter testing with a test board with some loss.
- Suggest that it may be better to provide min/max tap weights (as is done in CEI-25G-LR) rather than the precursor and postcursor fullscale range values. Left for future work.

Tx specification

Transmitter Characteristics at TP0				
Parameter	IEEE subclause reference	Value	Units	Comment
Nominal Signaling rate		25.78125	GBd	
Differential peak to peak output voltage (max)	72.7.1.4	1200	mV	same as KR and OIF
Differential peak to peak output voltage (max) with Tx disabled.	72.6.5	30	mV	same as KR
Common-mode voltage limits (max)	72.7.1.4	1.9	V	same as KR
Common-mode voltage limits (min)	72.7.1.4	0	V	same as KR
Differential output return loss (min)	72.7.1.5	TBD		
Common-mode output return loss (min)	72.7.1.6	TBD		
Common-mode AC output voltage (max, RMS)		12	mV	Same as OIF (ba was 30mV but includes a connector)
Transition time (20-80%) (min) de-emphasis off	72.7.1.7	8	ps	Same as OIF
Steady state output (Vf) (max) de-emphasis off	85.8.3.3	0.6	V	Same as OIF
Steady state output (Vf) (min) de-emphasis off	85.8.3.3	0.4	V	Same as OIF
Linear fit pulse (min) de-emphasis off	85.8.3.3	0.8*Vf	V	Same as OIF

Tx specification (cont)

Parameter	IEEE subclause reference	Value	Units	Comment
Transmitted waveform				
max normalized error (linear fit) "e"	85.8.3.3	0.037		same as 802.3ba
normalized coefficient step size (min)	85.8.3.3.2	0.0083		same as 802.3ba
normalized coefficient step size (max)	85.8.3.3.2	0.05		same as 802.3ba
minimum precursor fullscale range	85.8.3.3.3	1.54		same as 802.3ba
minimum postcursor fullscale range	85.8.3.3.3	4		same as 802.3ba
Far-end transmit output noise (max)				
Low insertion loss channel	85.8.3.2	2	mV	same as 802.3ba
High insertion loss channel.	85.8.3.2	1	mV	same as 802.3ba
Max output jitter (peak-to-peak)				
Random jitter	72.7.1.9	0.15	UI	same as 802.3ba and OIF
Duty Cycle Distortion	72.7.1.8	0.035	UI	same as 802.3ba and OIF
Total jitter excluding data dependent jitter.	83.5.10	0.28	UI	same as 802.3ba and OIF

Tx specification (cont)

These parameters are the same as OIF

Linear fit pulse and equalizing filter parameters

Parameter	Value (UI)
Linear fit pulse length T_N_p	8
Linear fit pulse delay T_D_p	2
Equalizer length T_N_W	8
Equalizer delay T_D_W	2

Channel Specification

- The Channel specification is proposed to be informative and similar to 10GBASE-KR and CEI-25G-LR

- IL_{max} ($f_b/2$) is targeted at 30 dB w/o FEC and 35 dB with FEC

- Fmin = 50 MHz,

- Proposed values for the parameters (scaled from OIF) are
  - Fmin<f<fb/2
    - With FEC   ILmax = 1.5 +4.60*sqrt(f)+1.318*f
    - Without FEC   ILmax= 1.27+3.94*sqrt(f)+1.130*f
      (f in GHz)
  - Fb/2<=f<fb
    - With FEC   ILmax = -12.71+3.70*f
    - Without FEC   ILmax= -10.90+3.17*f
      (f in GHz)

Channel Max loss Specification

Maximum Loss
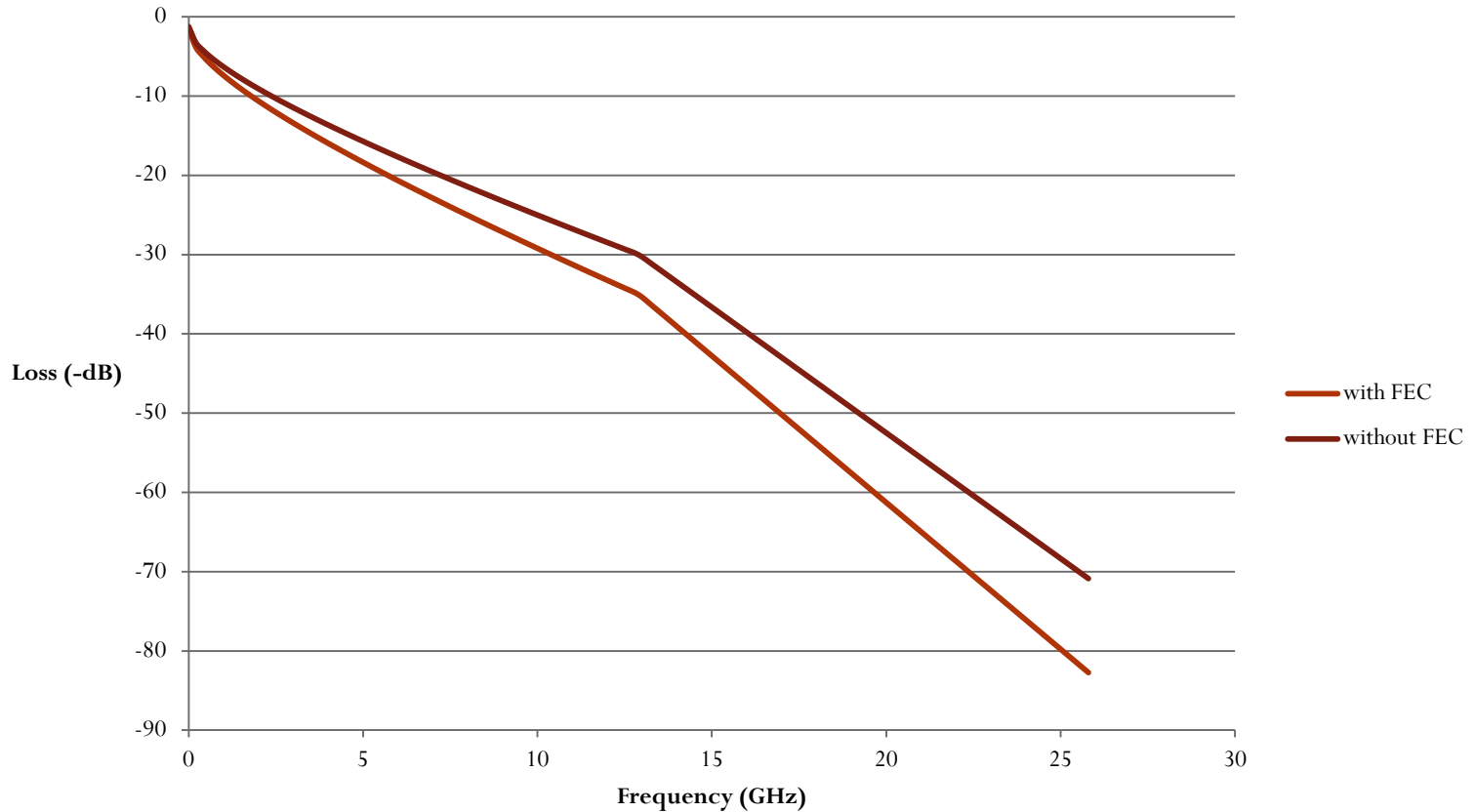
Channel Specification (continued)

- The measured insertion loss is fitted to the insertion loss equation using the OIF test methodology described in OIF document http://www.oiforum.com/public/documents/OIF_CEI_03.0.pdf section 12.2. The fitted insertion loss equation is listed below. Note that this test methodology fits the curve up to the signaling rate with the pass/fail limits for ILD and ILDrms to 0.75 signaling rate.

$$IL_{fitted}(f) = a_0 + a_1\sqrt{\frac{f}{f_b}} + a_2\frac{f}{f_b} + a_4\left(\frac{f}{f_b}\right)^2 \quad (dB)$$

Channel Specification (cont)

- Propose to limit the values of the "a" coefficients to restrict the amount of square root and square terms which are more difficult to equalize.

- ILD: Propose to specify an ILD envelope.

- ILDrms: Propose to specify ILDrms (the rms deviation of ILD) as defined in OIF. This would potentially be included in a trade-off with crosstalk and noise and channel loss. It may also be replaced by a different measure of integrated ILD based on work from the test methodology group).

- Crosstalk and noise: Propose to have a Max ICN allowance which is a function of loss at Nyquist. Loss to extend to 30dB for without FEC and 35dB with FEC for low ICN (and low ILDrms)

Channel Specification (cont)

- The differential return loss, differential to common mode return loss, and common mode return loss would also be specified, as well as the differential to common mode through response.

Rx specification

- The Rx is specified to meet the required BER when specific stressed input signals (including jitter, noise and insertion loss versus frequency) are applied.

- These input signals are generated by passing a degraded signal from a pattern generator through a maximum loss channel and a lower loss channel with more noise degradation. Also an even higher loss channel with the use of FEC

- Differential return loss, common mode return loss, and differential to common mode conversion would also be specified.

Conclusions

- A specification is proposed for a PAM2 backplane system achieving 30 dB loss at Nyquist without FEC and 35dB loss at Nyquist with FEC.

- Proposal is to adopt this as the baseline proposal for meeting an 802.3bj objective of 35 dB loss at 12.89 GHz