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Proposal to revert-back flexibility in TDECQ Definition

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Definition of TDECQ Draft 3.2

- To pass a Transmitter, TDECQ measurement uses 5 Taps, where 5 taps can be configured in three ways

Tap Set	Tap-1	Tap-2	Tap-3	Tap-4	Tap-5
No Pre Tap Set	Main	Post1	Post 2	Post 3	Post 4
One Pre Tap Set	Pre 1	Main	Post1	Post 2	Post 3
Two Pre Tap Set	Pre 2	Pre 1	Main	Post1	Post 2

At any given Data rate note, the optical transmitter has been the most difficult part to make and is generally the costliest part due to highest yield distractor. The flexibility provided by choosing three combinations of taps was key to be producing high yielding low cost transceivers. However, at the Pittsburg meeting, the last combination was removed which led to this work asking for reinstating all three combinations.

Information needed to restrict Tap set

- Statistical information on multiple type of optical modulators, e.g. EML, Silicon Photonics with associated interconnect between the CDR, Electrical amplifier etc
- Temp variation for various combinations

There are limited set of optical modulators and statistical analysis from multiple type of optical modulators from multiple vendors is prohibitive before the standard needs to close.

Due to limited time, we are presenting simulated data representing expected temp and process variations.

The Simulated Model

For 56Gbaud, every detail needs to be modeled. Every time there is a mode conversion, there is possibility of pre-cursor distortion. As the signal propagates, there are multiple points where the mode conversion could be happening and thus leading to variation in pre-cursor. Also the traveling amplifier and modulators will have varying pre-cursor due to various laws of physics they are build on.

Fair comparison between two tap sets

- Since transmitter can also correct for pre-cursor, we considered fix pre-correction of 2nd pre tap while considering 5 tap equalizer with one pre and three post taps.

Simulated Results over temp

Condition	Be_{eff} (GHz)	Ceq (dB)	-2pre	-1pre	Main	+1post	+2post	+3post	TDECQ (dB)
Room Temp Calibration Pre-cursor	29.1	0.9	**≡0.0301 FIXED**	-0.0866	1.1954	-0.0872	-0.0749	0.0232	1.82
High Temp 1 pre/ 3 post tap set Equivalent	22.6	1.6	**≡ 0.0327 FIXED**	-0.2302	1.4004	-0.1823	-0.0249	0.0043	3.75
High Temp 2 Pre / 2 Post tap set Equivalent	22.6	1.4	0.0764 adaptive	-0.2129	1.3507	-0.2016	-0.0126	---	2.84

Adaptive Tap Set

Adaptive Tap Set

Degradation in TDECQ = (3.75-2.84) = 0.91dB

What if 2nd pre is set based on WC?

Room Temp comparison if 2nd Pre tap calibrated at high temp

Condition	Be_{eff} (GHz)	Ceq (dB)	-2pre	-1pre	Main	+1post	+2post	+3post	TDECQ
Room Temp Calibration Pre-cursor	29.1	0.9	**≡0.0301 FIXED**	-0.0866	1.1954	-0.0872	-0.0749	0.0232	1.82
2nd Pre Fixed corresponding to High temp	29.1	0.6	**≡0.08 FIXED**	-0.0857	1.1420	-0.0877	-0.0717	0.0233	2.36

Adaptive Tap Set

Degradation at room temp = 2.36 – 1.82 = 0.54dB

Simulated Results with 2nd pre fixed for average of room temp and high temp

Condition Temp	2nd pre equalization	Be_{eff} (GHz)	Ceq (dB)	-2pre	-1pre	Main	+1post	+2post	+3post	TDECQ
Room Temp	2nd Pre Adapted	29.1	0.9	**≡0.0301 FIXED**	-0.0866	1.1954	-0.0872	-0.0749	0.0232	1.82
Room Temp	2nd Pre Fixed	29.1	0.6	**≡0.055 FIXED**	-0.0889	1.1686	-0.0846	-0.0734	0.0228	2.03
High Temp	2nd Pre Fixed	22.6	1.4	**≡ 0.055 FIXED**	-0.2256	1.3711	-0.1872	-0.0206	0.0029	3.15
High Temp	2nd Pre Adapted	22.6	1.4	0.0764 adaptive	-0.2129	1.3507	-0.2016	-0.0126	---	2.84

Degradation at room temp = 2.03 – 1.82 = 0.21dB
Degradation at high temp = 3.14-2.84 = 0.3dB

Conclusions

- Transmitters quality has been heavily debated in the standards using TDECQ. This started with the goal of supporting low cost, good quality transmitters.
- The flexibility provided till recently by choosing any of the three sets taps was assumed by many component providers
- We demonstrated that 2nd pre in the RX needs to be adapted as compared to a TX FIR.
- Every other 50G PAM4 and 100G PAM4 specification allow the 2nd pre-cursor:
  - 802.3bs 200GBASE-DR4, 400GBASE-DR4, 200GBASE-FR4, 200GBASE-LR4
  - 100G lambda MSA 100GBASE-FR, 100GBASE-LR
  - 802.3cd 50GBASE-SR, 100GBASE-SR2
- For 28Gbaud using two pre and two post cursors, it is using roughly 37.6X2 = 75.2ps of temporal coverage while 56Gbaud standard is limiting the pre cursor coverage to 18.8ps. Do we expect the optics to be improving by 4x in one generation?

Reinstate the original text to make 100GBASE-DR compatible with 50GBASE-SR/FR/LR, 100GBASE-SR2/FR/LR, 200GBASE-SR4/FR4/LR4 and 400GBASE-DR4, specs

Change
‘ Tap 1 or tap 2 has the largest magnitude tap coefficient’
To:
‘Tap 1, tap 2 or tap 3 has the largest magnitude tap coefficient’