

Retimer Functions in PCIe Protocol Interface

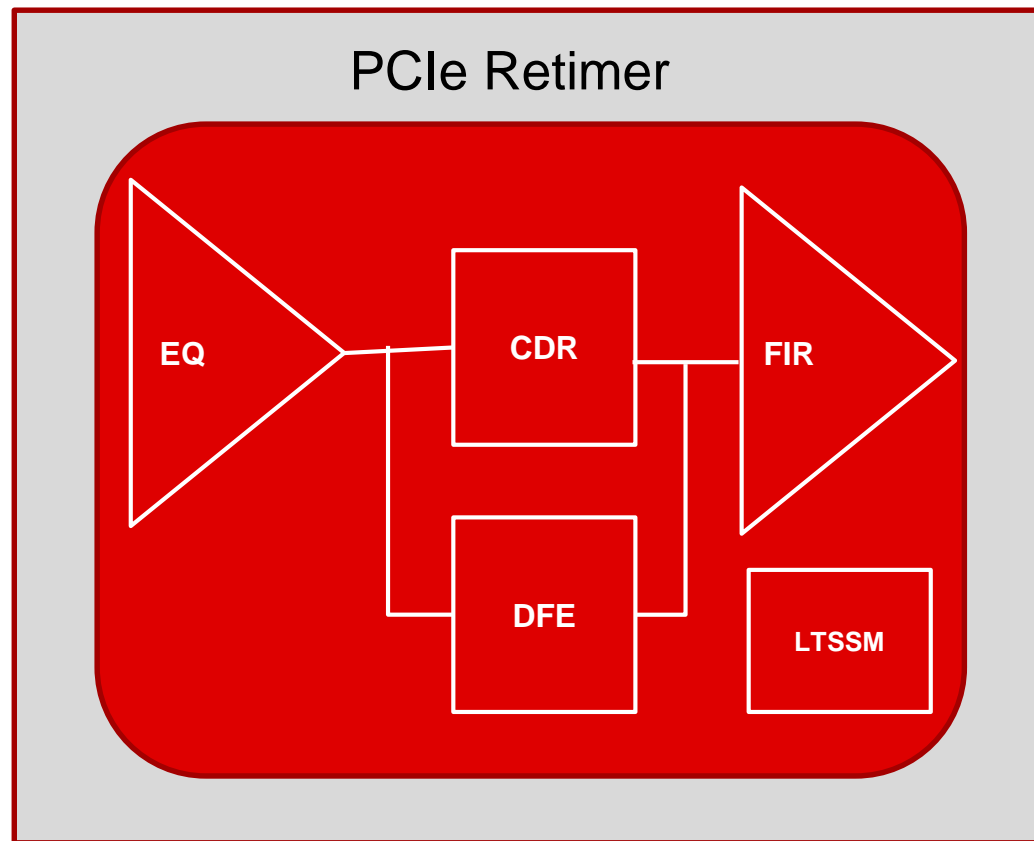
TI Precision Labs – PCIe

Prepared by Nasser Mohammadi

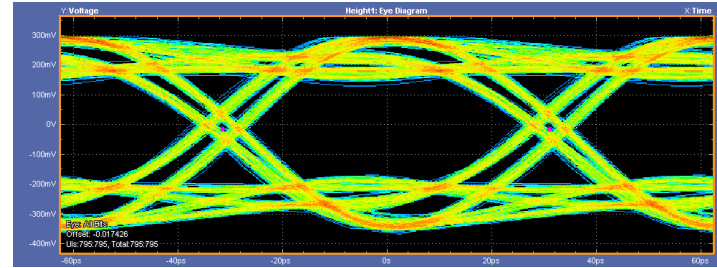
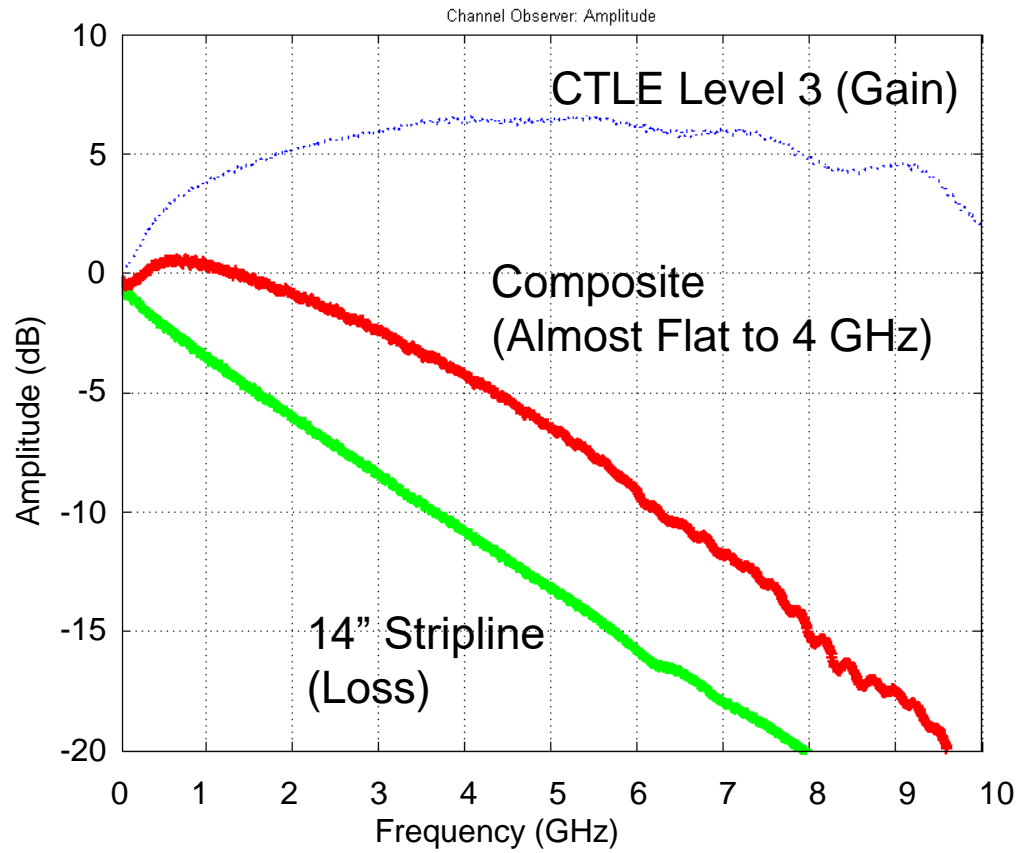
Presented by Nicholas Malone

What are retimer tasks in a PCIe protocol application?

- Analog Signal Conditioning:
Adaptive EQ + DFE + FIR
- Clock and Data Recovery(CDR)
- Protocol Aware: LTSSM

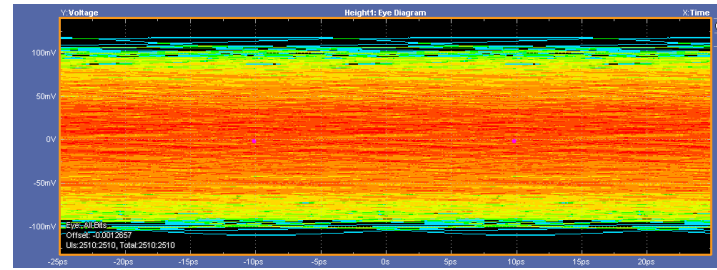


PCIe retimer task 1: analog signal conditioning

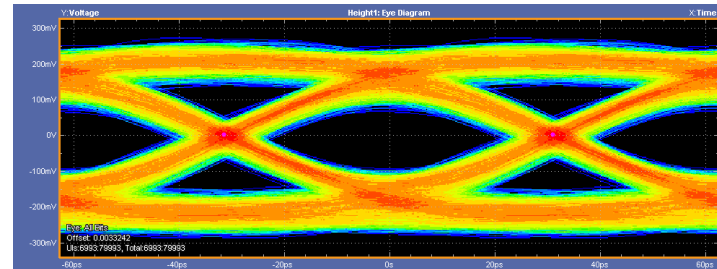


PCIe Tx Preset 7 at Source

- 16 Gbps PRBS-15
- Pre-Cursor: 3.5 dB
- Post-Cursor: -6 dB

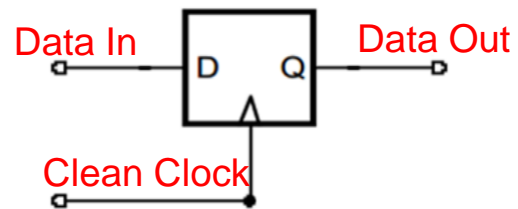
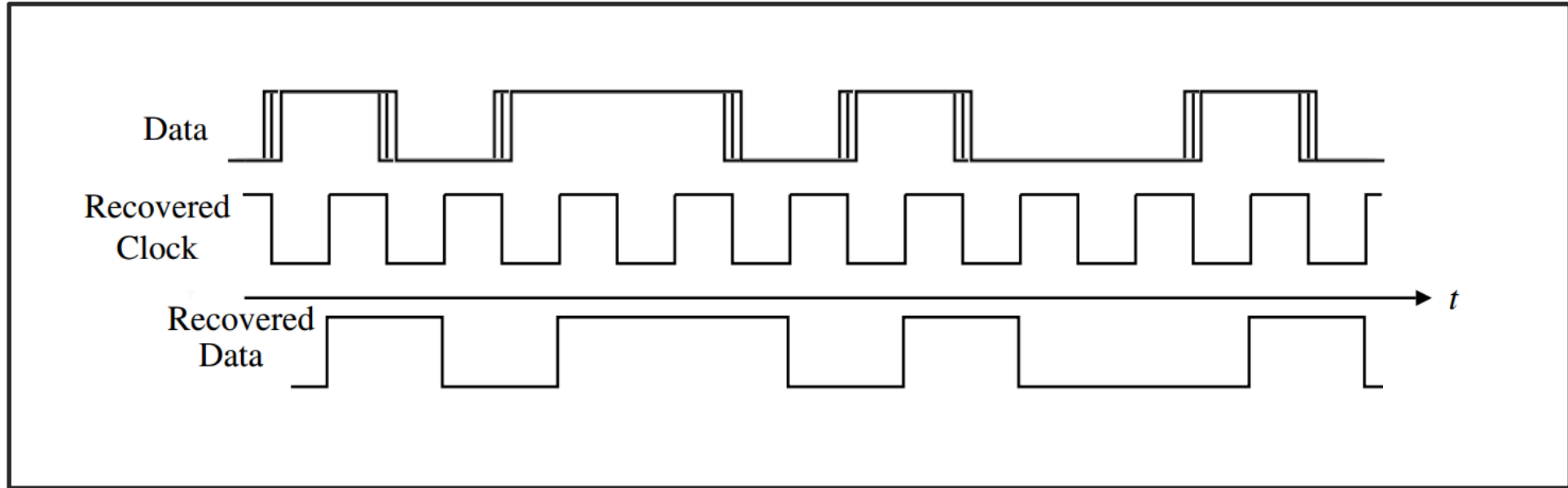


After 14" Stripline -20 dB @ 8 GHz Loss

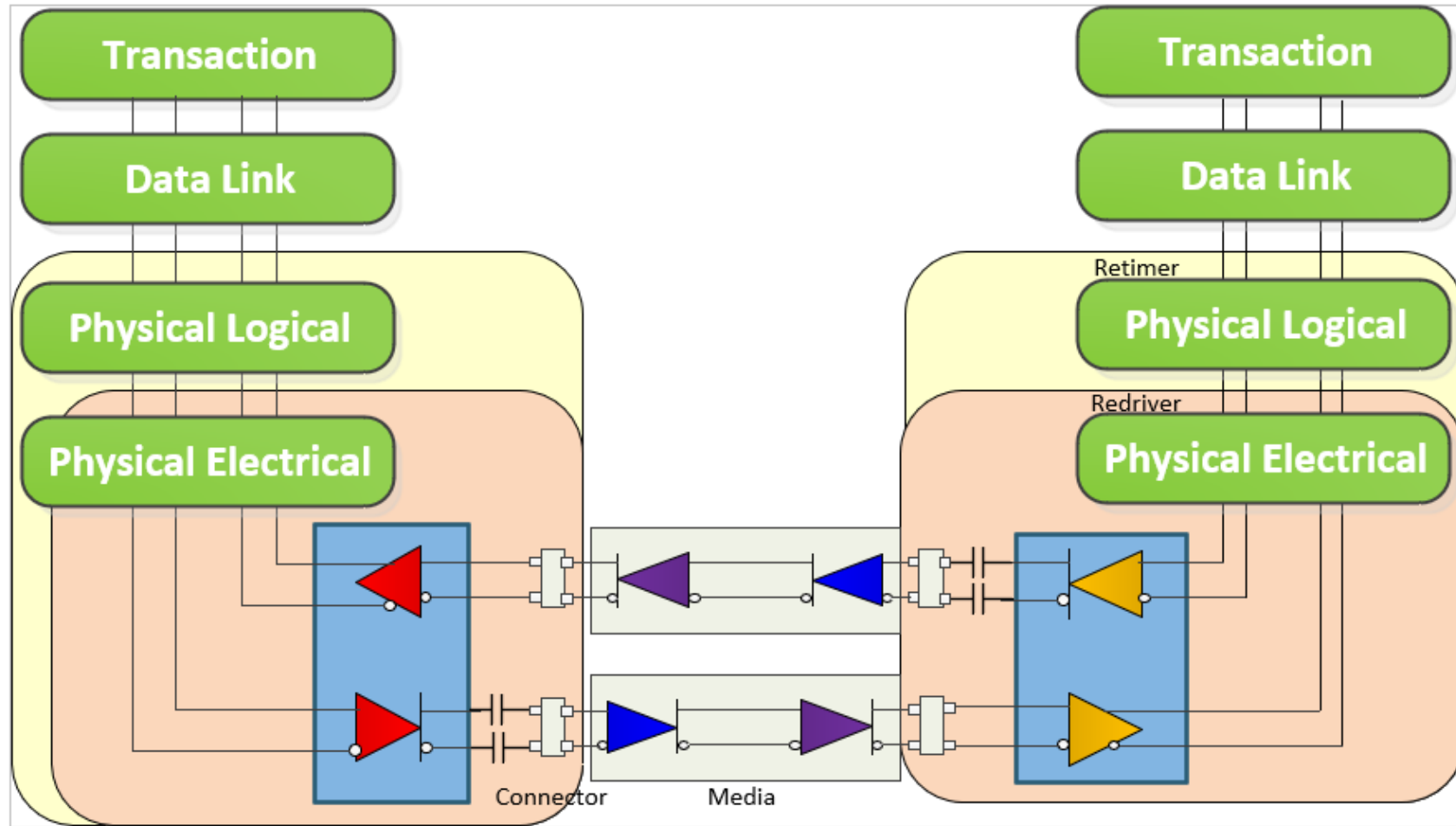


After Retimer CTLE level 3

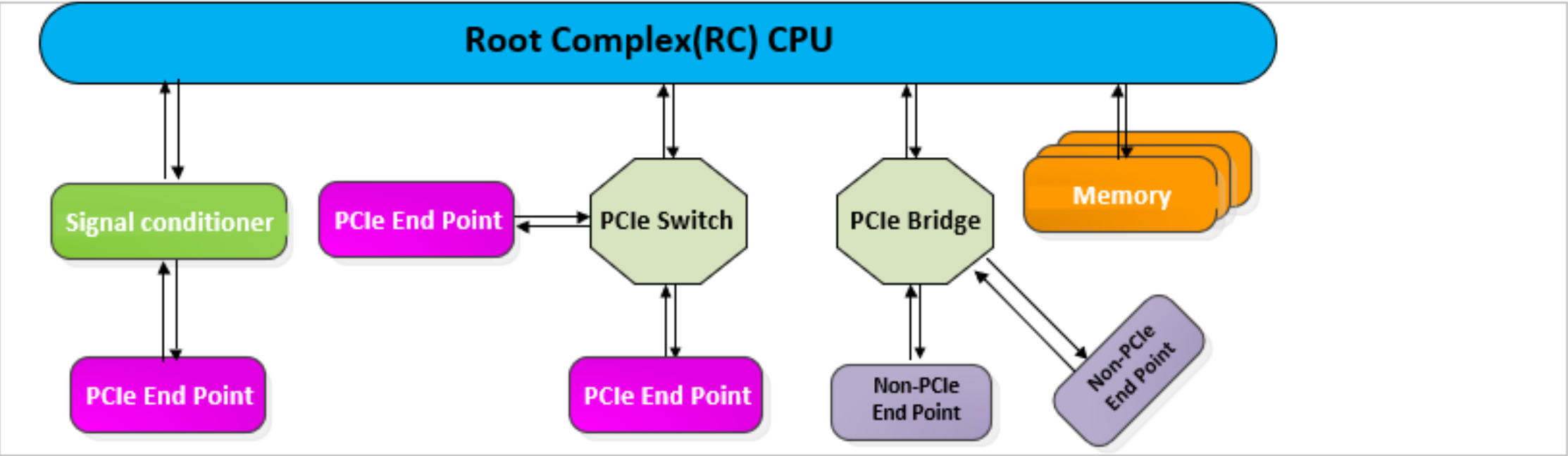
PCIe retimer task 2: CDR



PCIe retimer task 3: LTSSM overall protocol stack



PCIe retimer task: LTSSM overall PCIe topology



What is LTSSM used for?

- Negotiate link speeds:
 - Gen1: 2.5Gbps, Gen2: 5Gbps, Gen3: 8Gbps, Gen4: 16Gbps, Gen5: 32Gbps
- Adapt RX/TX signal conditioning parameters
 - RX Signal conditioning parameters: CTLE, multi-tap DFE
 - Pre/Post shoot settings
- Enter compliance mode at different data rates and presets
 - It is intended to make sure there is same electrical performance across different equipment
- Link recovery:
 - At certain bit error rate threshold, a lower data rate is automatically negotiated for reliable performance
- Enter L0, L1, L2, L3, and L0s power save mode

LTSSM negotiates Tx Presets

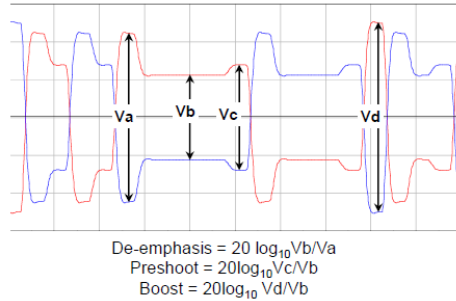


Figure 8-5: Definition of Tx Voltage Levels and Equalization Ratios

Table 8-1 lists the values for presets; at 8.0 GT/s and 16.0 GT/s all preset values must be supported for full swing signaling.

Table 8-1. Tx Preset Ratios and Corresponding Coefficient Values

Preset #	Preshoot (dB)	De-emphasis (dB)	c-1	c+1	Va/Vd	Vb/Vd	Vc/Vd
P4	0.0	0.0	0.000	0.000	1.000	1.000	1.000
P1	0.0	-3.5 ± 1 dB	0.000	-0.167	1.000	0.668	0.668
P0	0.0	-6.0 ± 1.5 dB	0.000	-0.250	1.000	0.500	0.500
P9	3.5 ± 1 dB	0.0	-0.166	0.000	0.668	0.668	1.000
P8	3.5 ± 1 dB	-3.5 ± 1 dB	-0.125	-0.125	0.750	0.500	0.750
P7	3.5 ± 1 dB	-6.0 ± 1.5 dB	-0.100	-0.200	0.800	0.400	0.600
P5	1.9 ± 1 dB	0.0	-0.100	0.000	0.800	0.800	1.000
P6	2.5 ± 1 dB	0.0	-0.125	0.000	0.750	0.750	1.000
P3	0.0	-2.5 ± 1 dB	0.000	-0.125	1.000	0.750	0.750
P2	0.0	-4.4 ± 1.5 dB	0.000	-0.200	1.000	0.600	0.600
P10	0.0	Note 2.	0.000	Note 2.	1.000	Note 2.	Note 2.

Notes:

1. Reduced swing signaling must implement presets P4, P1, P9, P5, P6, and P3. Full swing signaling must implement all the above presets.
2. P10 boost limits are not fixed, since its de-emphasis level is a function of the LF level that the Tx advertises during training. P10 is used for testing the boost limit of Transmitter at full swing. P1 is used for testing the boost limit of Transmitter at reduced swing.

What are Tx Presets used for?

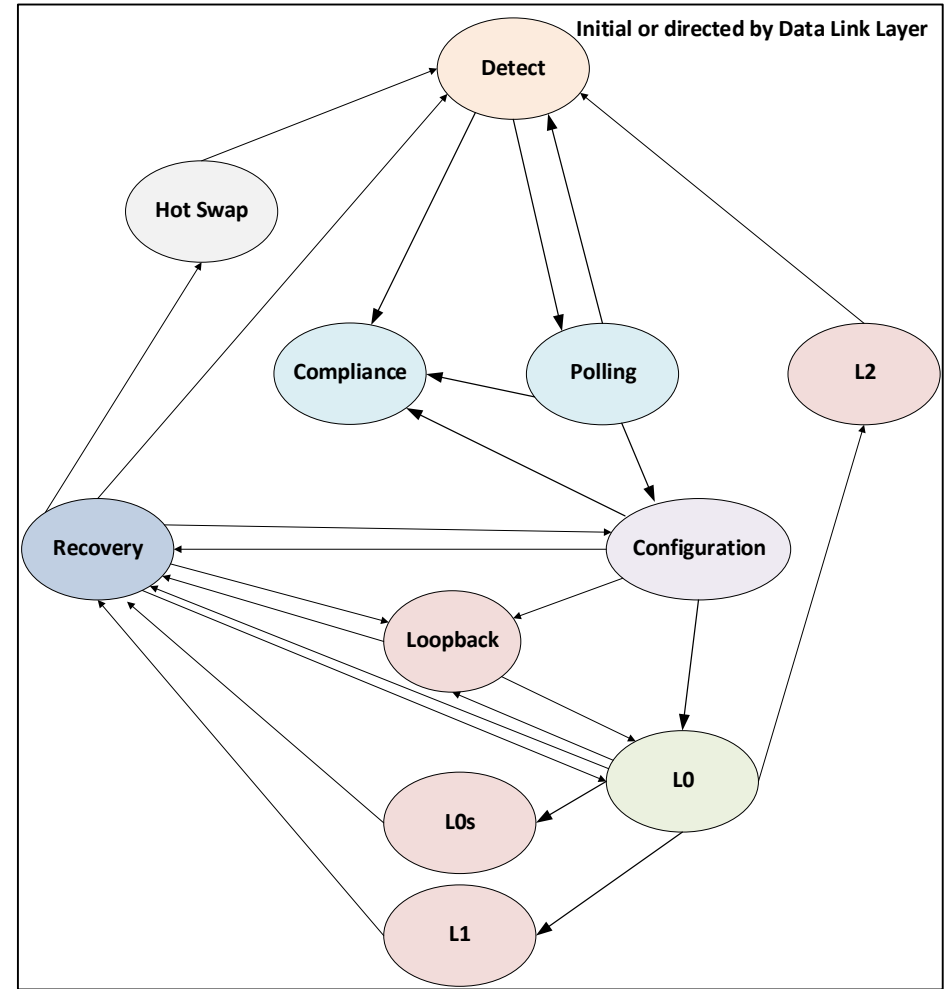
- Presets limited to 11 known combination of preshoot and de-emphasis values (P0 to P10)
- Source Tx Preset and Sink Rx EQ used together to improve overall signal integrity for optimal BER

How do Tx Presets affect SigCon?

- **Retimer:** Retimer is expected to respond to Preset requests from far end Rx RC or EP and drive outputs with Tx presets compliant to Tx Preset specifications.
- **Redriver:** Redriver linearity and CTLE gain performance is critical to maintain preshoot and de-emphasis characteristics at driver output.

LTSSM State machines details

- Negotiation starts with RX detection
- Gen1 training sequence exchanges capabilities and perform basic link configuration such as assigning lane numbers
- Gen3 starts after link goes idle
- Gen4 starts after Gen3 link goes idle



Thank you

- TI Precision Labs – PCIe Solving Signal Integrity Challenges

The screenshot shows the TI E2E support forums homepage. At the top left is the Texas Instruments logo and the text "TEXAS INSTRUMENTS". To the right is a "Login / Register" link. Below this is a red navigation bar with "E2E™ support forums >" followed by links for "Forums", "Technical articles", "TI training", and "Getting started". On the far right of the navigation bar is a globe icon and the text "简体中文".

The main content area starts with the heading "Welcome to the TI E2E™ support forums". Below this is a paragraph: "TI E2E support forums are an engineer's go-to source for help throughout every step of the design process. Our engineers answer your technical questions and share their knowledge to help you quickly solve your design issues."

Below the paragraph is a search bar with the text "Start by searching thousands of existing answers to see if the solution to your problem is already online." and a search icon. The search bar contains the text "Search TI E2E by part number and/or keyword. (e.g. OPA333 output peaking)".

At the bottom of the search bar area, there are two statistics: "2,270 Contributing TI employees" and "345,592 Issues resolved".



©2022 Texas Instruments Incorporated. All rights reserved.

The material is provided strictly "as-is" for informational purposes only and without any warranty.
Use of this material is subject to TI's **Terms of Use**, viewable at [TI.com](https://www.ti.com)