



Transmit Deterministic Jitter

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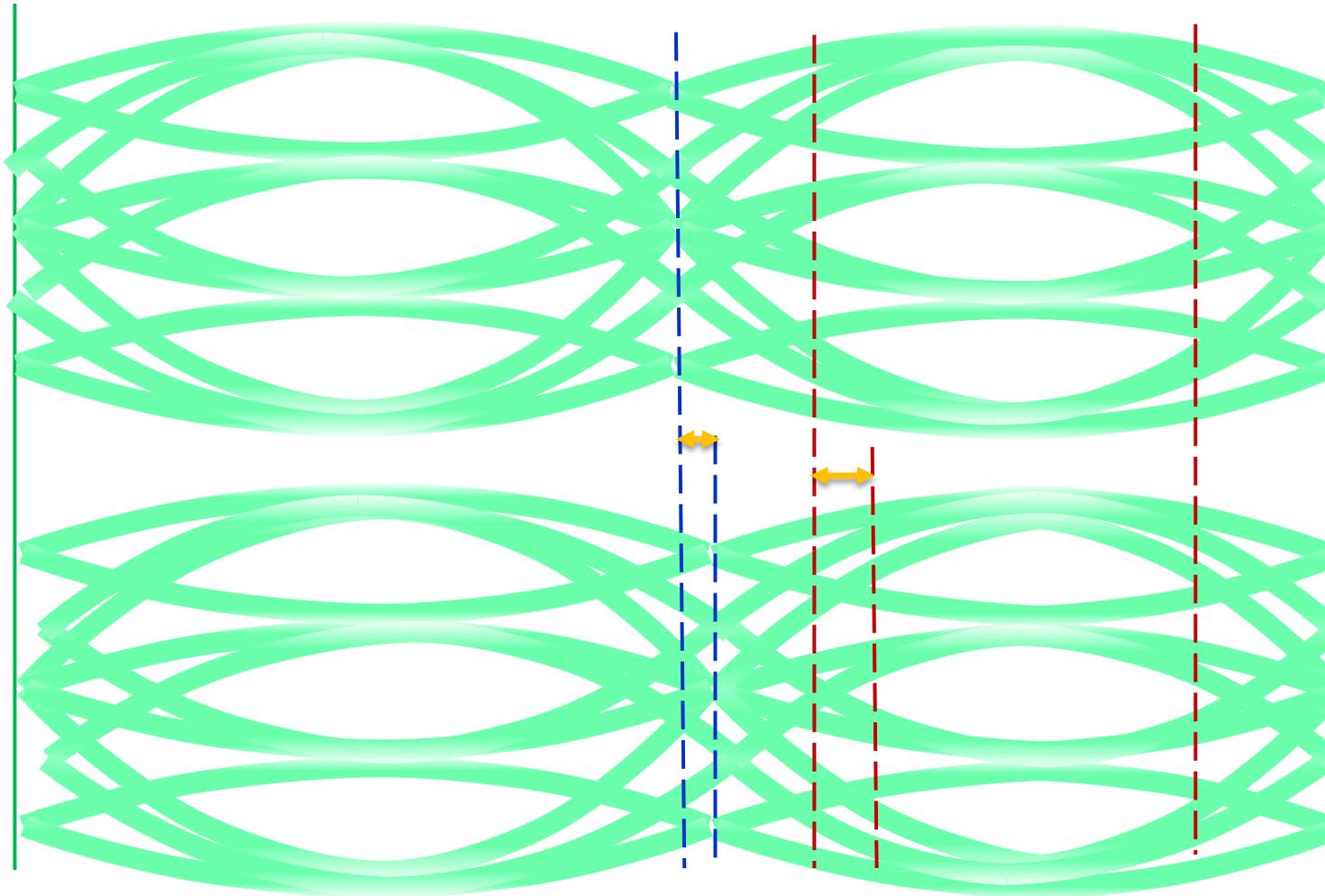
Background of Deterministic Jitter Spec

- The deterministic jitter (DJ) has been a spec for the SerDes links since early years when baud rates exceeded 1Gbaud.
- People added DJ spec because it started causing interoperability problems.
- DJ components, like even-odd jitter (EOJ), increases as signal travels in a low-pass channel
- Moving to higher level modulations, PAM4 here, makes DJ an even bigger concern....

EOJ Amplification in PAM4 Signaling

Even Eye

Odd Eye



- The Deterministic Even-Odd Jitter (EOJ) gets amplified on the top & bottom eye openings of a PAM4 eye diagram even with little low-pass effects
- With a large enough EOJ, there will not be one optimum equalization setting for both the Even and Odd eye, therefore we always end up with non optimized ISI cancellation

DJ Specs Necessary for Bidirectional Links?

- Echo cancellation already puts a tighter limit on jitter. Is there a need to set additional DJ specs?
- Two considerations:
 - DJ components like even-odd jitter (EOJ) can cause more problem for channel equalization
 - High EOJ can lead to large imbalance of ISI between consecutive symbols (higher ISI in one symbol and lower in the next).
 - It directly affects the performance of the link-partner equalizer that can never cancel ISI properly
 - A PHY design may have an Echo canceller filter that is immune to DJ components.
 - For example in case of EOJ, an echo cancellation filter with 2x parallel path (where one path cancels even symbols and the other cancels the odd symbols) properly takes care of self echo cancellation despite having large Transmit EOJ jitter

Proposal: Use Scaled Jitter Specs from 802.3bj

149.5.1 Test Modes → Modify Test Mode 2 as follows

Test mode 2: Transmit MDI Jitter in Master Mode

Test mode 2 is for transmitter jitter testing on MDI when transmitter is in MASTER timing mode. When test mode 2 is enabled, the PHY shall transmit a continuous pattern of JP03A (as specified in Clause 94.2.9.1) or JP03B (as specified in Clause 94.2.9.2) with the transmitted symbols timed from its local clock source.

149.5.2.3 Transmit Timing Jitter → Add the following to Transmit Timing Jitter

149.5.2.3.2 Transmit MDI Deterministic Jitter in Master Mode

Jitter measurements in this subclause are performed with transmitter is enabled in Master timing mode with a local clock.

- To measure the peak-to-peak Deterministic Jitter (DJ_{pk-pk}) follow steps as specified in Clause 94.3.12.6.1, with following modifications:

$$f_n = 1\text{MHz} \times s, T = 68\text{ns}/s \quad (\text{where } s=1 \text{ @ } 10\text{G}, s=0.5 \text{ @ } 5\text{G}, s=0.25 \text{ @ } 2.5\text{G})$$

- To measure peak-to-peak Even-odd jitter (EOJ_{pk-pk}) measurement follow steps as specified in Clause 94.3.12.6.2.

→ The calculated transmit timing jitters for DJ and EOJ from above measurements should meet:

$$DJ_{pk-pk} < 9\text{ps}/s, \quad EOJ_{pk-pk} < 4\text{ps}/s$$

(where $s=1$ @ 10G, $s=0.5$ @ 5G, $s=0.25$ @ 2.5G)

Thank you.

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