Refinement to XLAUI/CAUI Electrical Specifications

IEEE P802.3ba
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Summary

- Addressing xAUI channel SDD21/SDD11
- How to define transmit de-emphasis
- How to guarantee near end mask will guarantee far end compliance over worst case xAUI channel
- Improvement in jitter methodology
- Method of meeting BER 1E-15 without increasing the test time
XLAUI/CAUI Channel SDD11 (Informative)

- As shown in ghiasi_01_0708 include xAUI mask below per comment 49 and 61
  - The cascaded channel with 10+ dB loss at Nyquist its SDD11 is degrades about 3 dB.

Data shown up to 20 GHz but the mask should stops at 11.1 GHz

\[
\text{Eqn SDD11 Mask_8431} = \begin{cases} 
14.5 & \text{if } (\text{freq} \leq 5e9) \\
-23.25 + 8.75 \times (\text{freq/5e9}) & \text{else} 
\end{cases}
\]

\[
\text{Eqn SDD11 Mask_CAUI} = \begin{cases} 
-12.5 & \text{if } (\text{freq} \leq 5e9) \\
-12.5 + 27.5 \times \log10(\text{freq/5e9}) & \text{else} 
\end{cases}
\]
XLAUI/CAUI Channel SDD21 (Informative)

- As shown in ghiasi_01_0708 include xAUI mask below per comment 48
  - The 10 dB channel was created by cascading 2\textsuperscript{nd} PCB with 2 dB loss at Nyquist with the 8” Fr4-8 channel which is adding some ripple.

Data shown up to 20 GHz but the mask should stops at 11.1 GHz

\begin{equation}
\text{CAUI Mask} = \begin{cases} 
-0.141 - 1.323 \cdot \sqrt{\text{freq}/1e9} - 1.333 \cdot \text{freq}/1e9 \\
-21 & \text{if } \text{freq} < 7e9 \\
15.1 - 4 \cdot \text{freq}/1e9 & \text{if } \text{freq} = 8e9 \\
-21 & \text{if } \text{freq} = 9e9 \\
-21 & \text{else} 
\end{cases}
\end{equation}
Updated nAUI SDD21 Loss

- Loss increased to 10.5 dB from 10 dB
  - $\text{SDD21}(10.5 \text{ dB}) = -0.15 - 1.39\sqrt{f} - 1.4f$ from 0.25 to 7 GHz
  - $\text{SDD21}(10.5 \text{ dB}) = 15.86 - 4.2 \times f$ from 7 to 11.1 GHz
Simplified Approach to Test xAUI Transmitter (comment 50, 53, 54)

- Define the following parameters
  - Transmit max output = 760 mV p-p (already defined)
  - Min VMA = as function of rise and fall time
  - Min de-emphasis = 4.7 dB
  - Min Tr/Tf 20-80% = 24 ps (already defined)
  - Max Tr/Tf 20-80% = limited by the de-emphasis and max transmitter
  - At this point define transmitter jitter with de-emphasis off and continue to investigate better method.
De-emphasis Definition and Measurement

- $V_{p-p}$ is the peak amplitude
- $V_{MA}$ is the peak to peak voltage when measured with 8 ones and 8 zero pattern over histogram window defined below. Use of PRBS9 is an acceptable alternative
- De-emphasis $dB = 20 \log_{10}(V_{p-p}/V_{MA})$
The Impact of Rise Time on Far End Compliance with 8+dB Channel

- The 8+dB channel response is little better than xAUI channels
  - Include worst case xtalk from min loss channel.

TX Ampl = 400 mV p-p
Tr=24 ps
de-emphasis=3.9 dB

TX Ampl = 550 mV p-p
Tr=40 ps
de-emphasis=3.9 dB

TX Ampl = 780 mV p-p
Tr=50 ps
de-emphasis=3.9 dB
The Impact of Rise Time on Far End Compliance with 10+dB Channel

- The 10+ dB loss channel has worse response than xAUI channels
  - Include worst case xtalk from min loss channel.

TX Ampl = 500 mV p-p
Tr=24 ps
de-emphasis=5.5 dB

TX Ampl = 620 mV p-p
Tr=34 ps
de-emphasis=5.5 dB

TX Ampl = 780 mV p-p
Tr=44 ps
de-emphasis=5.5 dB
More xAUI Eye Diagrams

- The combination of slow transmitter and low driver output fails the far end mask!

- TX Ampl = 500 mV p-p
  - Tr=24 ps
  - de-emphasis=5.5 dB
  - 0 dB loss channel

- TX Ampl = 500 mV p-p
  - Tr=44 ps
  - de-emphasis=5.5 dB
  - 10+dB loss channel
Proposed min VMA as Function of Transmitter Rise Time (comment 53)

- The combination of slow transmitter with weak drive could result in failing the far end mask!
- TX VMA = $(234.64 - 2.13\times x + 0.13\times x^2) \times 1.6 \times 10^{-de-emp/20}$, $x$ is max $(tr,tf)$ 20-80%  
  - 10dB+ channel de-emph=5.5 dB (more stressful channel)  
  - 8dB+ channel de-emph=3.9 dB (less stressful channel)  
  - Propose min de-emph=4.8 dB (compromise value)
Improved Jitter Methodology (comments 52, 55, 56, 57, and 58)

- Due to issue with dual-dirac methodology per MJSQ CL86 is moving to J2(eye opening at BER 1e-2), J9(eye opening at BER 1E-9), etc.
  - J2, J9, or J12 can be measured directly on the BERT without any jitter breakdown which may result in DJ reduction as RJ is increased.
  - J2 measures high probability jitter required for CDR robust locking
  - J12 guarantee target BER

- Table 83A-1 transmitter jitter
  - TJ=0.32 UI, DJ=0.17 UI resulting in J2=0.23 UI and J12=0.32 UI

- Table 83A-2 receiver jitter
  - TJ=0.62 UI, non-EQJ=0.42 UI resulting in J2=0.47 UI and J12=0.62 UI
How to Offer BER of $\sim1\text{E}-15$ without Test Time Complications

- Limit the channel output jitter to $J_2=0.47$ UI and $J_{12}=0.62$ (TP3)
- Test receiver tolerance with $J_2=0.48$ UI and $J_{15}=0.65$ UI (TP4)
  - Jitter added to make up 0.65 UI assumed to be RJ for worst case BER of $1\text{E}-15$. 

![Effect of Jitter on BER](image-url)
Impact of Larger TX RJ on the BER

- Amount of TP3 RJ was increased and DJ reduced by 5 ps
  - J2=0.41 UI, J12=0.32 UI
- With practical amount of RJ increase
  - The BER varies from 1E-14 to 1E-16