Refinement to XLAUI/CAUI Electrical Specifications

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Summary

- Update to nAUI channel SDD21
- Defining nAUI compliance point
- Updating module and host return loss based cascaded effect of connector and chip
- Shifting nAUI compliance from chip ball to 1 dB loss point
- Shifting nAUI compliance from the module by the MCB loss
- Verifying far end compliance for several corner cases

Addressing comments: 405, 407, 408, 409, 410, 411, 412, 419, 420
Where should MCB and HCB Measurement Point be?

• Where should HCB reference point be?
  – Naturally it can be at the end of module PCB With 2.1 dB of loss

• Where should MCB reference point be?
  – At end of 7.9 dB channel
    • A short circuit at connector will have RL of 15.8 dB!
  – At minimum loss from the connector but physically implementable
    • Propose 1 dB at 5.5 GHz

Chip Compliance Point
Propose 1 dB@5.5GHz

Module PCB up to 2.1 dB
Host up to 7.9 dB

Figure 83B–1—Chip-module loss budget

MCB Compliance Point
Propose 1 dB@5.5 GHz

HCB Compliance Point
Propose 2.1 dB@5.5GHz
XLAUI/CAUI Channel with 10.5 dB Loss

- This is an improved version over ghiasi_01_0708 which had some undesirable ripple and available from the http://www.ieee802.org/3/ba/public/channel.html
  - The 10.5 dB channel was created by cascading 2 dB loss PCB at Nyquist with the 8” Fr4-8 channel.
nAUI Module MCB with 3.6 dB Loss


\[
\text{Eqn: } \text{SDD11}_{\text{nAUI}} = \begin{cases} 
-12.5 & \text{if } \text{freq} < 5e9 \\
-12.5 + 27.5 \times \log_{10}(\text{freq}/5e9) & \text{otherwise}
\end{cases}
\]
Bringing nAUI Channel Loss in Sync

- Proposed SDD21 masks will make CL83A and CL83B in sync
nAUI SDD21 Channel Loss cont.

• Chip to chip loss SDD21=10.5 dB@5.5 GHz (already in D2.0)
  – SDD21(dB)= -0.140 – 1.32*sqrt(f) – 1.32*f from 0.25 to 7 GHz
  – SDD21(dB) = 15.02 -3.98 * f from 7 to 11.1 Ghz

• Chip to module channel SDD21=7.9 dB@5.5 GHz (detail missing)
  – SDD21(dB) = -0.11 – 0.99*Sqrt(f) – 1.00*f from 0.25 to 7 GHz
  – SDD21(dB) = 11.32 -2.99 * f from 7 to 11.1 Ghz

• Module PCB channel SDD21=2.1 dB@5.5 GHz (detail missing)
  – SDD21(dB) = -0.04 – 0.33*Sqrt(f) – 0.32*f from 0.25 to 7 GHz
  – SDD21(dB) = 3.72 - f from 7 to 11.1 Ghz
Creating nAUI Compliance Output

• SerDes with worst case return loss + channel with 1 dB loss at Nyquist
  – No need to make any changes to the host chip RL

Eqn: \( nAUI_{RL} = \begin{cases} 
-12 & \text{if} \quad \text{freq} < 2.125 \times 10^9 \\
-6.5 + 3.33 \times \log_{10}(\text{freq}/5.5) & \text{else}
\end{cases} \)
Loss from Chip Ball to Chip Compliance Point

- Current value in the draft are 0.7 dB, this was scaled to 1 dB at 5.5 GHz for easier PCB routing and channel availability

\[ \text{Eqn} \quad \text{DUT\_SDD21} = 0.00086 - 0.2286 \sqrt{\text{freq}/1e9} - 0.08386 \cdot \text{freq}/1e9 \]
Module Return Loss

- Current host & module limits from SFP+ limits are based on SerDes RL 2 dB better!
  - Current mask limit (SDD11_D2) almost touches the mask, propose limit is SDD11_D21
- Assumes 0.5 dB PCB loss @5.5 Ghz and 1 dB for the MCB
Host Return Loss

- Current host & module limits from SFP+ limits are based on SerDes RL 2 dB better!
  - Current mask limit (SDD11_D2) not optimum for host mask, propose limit is SDD11_D21
- Assumes min PCB loss of 0.5 dB@5.5 Ghz and 2 dB loss @5.5 Ghz for the HCB

```
Eqn SDD21_mask=if(freq<7e9) then (-0.15 - 1.39*sqrt(freq/1e9) - 1.4*freq/1e9) else (15.76 -4.2*freq/1e9)
Eqn SDD11_D2=if(freq<4.11e9) then (-12+2*sqrt(freq/1e9)) else (-6.3+13*log10(freq/5.5e9))
Eqn SDD11_D21= if(freq<1e9) then (-12) else (-5.56+8.7*log10(freq/5.5e9))
```
nAUI Compliance Output

- Chip measured with 1 dB DUT board
- Module measured with 1 dB MCB board and assumed module PCB has 2.1 dB loss
- Impact of rise/fall time at nAUI compliance point illustrated below
  - Since the compliance measurement already has some PCB loss the minimum de-emphasis amount will be lower.
Translating Device Setting to nAUI Device DUT Output

- Vtx-demph was adjusted to give same far end eye opening for 10 dB channel then the output measured with 1 dB DUT board
  - Vtx-demph=(234.64 -2.13*x +0.18*x^2)*1.32*(10^y/20)
- The de-emphasis range y is from 4.4 dB to 7.4 dB calibrated at DUT output
  - The device de-emphasis was 7.5 dB
- Next investigate 4 corner cases A, B, C, and D for far end compliance
Near End and Far End Eyes

nAUI Near

Case A
5.2 dB
Tr=24 ps

Case B
3.3 dB
Tr=24 ps

nAUI Far
Near End and Far End Eyes

**nAUI Near**

- Case C
  - 5.2 dB
  - Tr=44 ps

**nAUI Far**

- Case D
  - 3.3 dB
  - Tr=44 ps
Translating Device Setting to nAUI Module MCB Output

- Vtx-demph was adjusted to give same far end eye opening for 10 dB channel then the output measured with MCB
  - Vtx-demph = \((-110 - 2.13 \times x + 0.32 \times x^2) \times (10^y/20)\)
- The de-emphasis range y varies from 3.5 dB to 6 dB calibrated at MCB output
  - The device de-emphasis was 7.5 dB

- Next investigate 4 corner cases A, B, C, and D for far end compliance
Near End and Far End Eyes

Case A
6 dB
Tr=39 ps

Case B
3.5 dB
Tr=39 ps
Near End and Far End Eyes

Case C
3.5 dB
Tr=46 ps

Case D
6 dB
Tr=46 ps
Verifying Module MCB Jitter Output

- The current DJ and TJ values are in line with worst case MCB output

\[
\text{DJ} = 0.22 \text{ UI} \\
\text{TJ} = 0.385 \text{ UI}
\]
Summary

- Proposed to define nAUI compliance at 1 dB loss at Nyquist to allow practical PCB test board and breakout
- The de-emphasis, rise time, and Vtx-demph are shifted to the nAUI TX/RX compliance point.
  - Chip-Chip compliance point was move to 1 dB@5.5 Ghz
  - Module compliance point was moved to 3.6 dB@5.5 Ghz
  - The de-emphasis and rise/fall time were then adjusted based on the chip or module observable compliance point
- Module return loss adjusted assuming min channel and MCB loss
- Host return loss was adjusted based on HCB loss and with channel
- Proposed de-emphasis, Tr/Tf, and Vtx-demph guarantee far end compliance for CL83A and CL83B.