Supporting material for clause 85
Draft 1.1 comments

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Objective

• Technical completion of Clause 85
• Resolve TBDs and Editors notes
• Comments, 302,308,303,296,305,307,306,297, 309 and 663 (Tom Palkert comment).
802.3ba CR4 and CR10
Transmitter Specifications and Test Points
Proposal

• Table 85-4 Transmitter characteristics to be met at TP0.
  - Draft 1.1. Table 85-4 transmitter characteristics don't change.
  - Common reference point for the transmitter specifications and test fixture definitions for both KR and CR.

• Adjust applicable Table-85-4 transmitter specifications at TP0 to specify TP2.
802.3ba / 802.3ap compare

**PMD Service Interface**

**CR4 or CR10 transmit function**

**TP0**

**TM1**

**TP2**

**TP3**

**TP4**

**CRn Receive Function Including AC – coupling**

**PMD Service Interface**

**Tx_bit<>**

**Rx_bit<>**

**MDI**

**n pair Twinaxial cable**

**n=4,10,…**

**PMD Service Interface**

**Tx_pcb**

**Rx_pcb**

**PMD**

**TP5**

**Test/Reference Points**

**backplane connector**

**x4 backplane**

**Backplane channel**

**802.3ba – CR4 and CR10**
CR4/CR10 - Transmitter characteristics @ TP0

- CR4 and CR10 transmitter characteristics specified at TP0.
- Remove Table 85-4 TBDs

Table 85-4—Transmitter characteristics' summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Subclause reference</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signaling speed, per lane</td>
<td>85.8.3.3</td>
<td>10.3125 ± 100 ppm</td>
<td>GBd</td>
</tr>
<tr>
<td>Unit interval nominal</td>
<td>85.8.3.3</td>
<td>96.969697</td>
<td>ps</td>
</tr>
<tr>
<td>Differential peak-to-peak output voltage (max.) with TX disabled</td>
<td>72.6.5 or 85.8.3.x</td>
<td>36(TBD)</td>
<td>mV</td>
</tr>
<tr>
<td>Common-mode voltage limits</td>
<td>72.7.1.4 or 85.8.3.x</td>
<td>0–1.2(TBD)</td>
<td>V</td>
</tr>
<tr>
<td>Differential output return loss (min.)</td>
<td>72.7.1.5 or 85.8.3.x</td>
<td><a href="TBD">See Equation (72–4) and Equation (72–5)</a></td>
<td>dB</td>
</tr>
<tr>
<td>Common-mode output return loss (min.)</td>
<td>72.7.1.6 or 85.8.3.x</td>
<td><a href="TBD">See Equation (72–6) and Equation (72–7)</a></td>
<td>dB</td>
</tr>
<tr>
<td>Transition time (20%–80%)</td>
<td>72.7.1.7 or 85.8.3.x</td>
<td>24–47 (TBD)</td>
<td>ps</td>
</tr>
<tr>
<td>Max output jitter (peak-to-peak)</td>
<td>72.7.1.8 or 85.8.3.x</td>
<td>0.15(TBD)</td>
<td>UI</td>
</tr>
<tr>
<td>Random jitter</td>
<td></td>
<td>0.15(TBD)</td>
<td>UI</td>
</tr>
<tr>
<td>Deterministic jitter</td>
<td></td>
<td>0.05(TBD)</td>
<td>UI</td>
</tr>
<tr>
<td>Duty Cycle Distortion</td>
<td></td>
<td>0.28(TBD)</td>
<td>UI</td>
</tr>
</tbody>
</table>

*Jitter is specified at BER $10^{-12}$.

*Duty Cycle Distortion is considered part of the deterministic jitter distribution.
CR4/CR10 – Transmitter test fixture @ TP0

- Replace 85.8.3.1 Test fixtures with Figure 85–X—Transmit test fixture at TP0.

Figure 85–X—Transmit test fixture at TP0

Figure 72–7—Transmit test fixture for 10GBASE-KR

802.3ba – CR4 and CR10
CR4 and CR10 transmitter characteristics specified at TP2.
- Do we need to specify at TP2 in addition to TP0?
- What to specify?
- What are the values?
- Test fixture?

Proposal to be provided prior to the meeting.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differential peak-to-peak output voltage (max.) with TX disabled (max.)</td>
<td>NA</td>
</tr>
<tr>
<td>Common-mode voltage limits</td>
<td>NA</td>
</tr>
<tr>
<td>Differential output return loss (min.)</td>
<td>NA</td>
</tr>
<tr>
<td>Common-mode output return loss (min.)</td>
<td>NA</td>
</tr>
<tr>
<td>Transition time (20%–80%)</td>
<td>NA</td>
</tr>
<tr>
<td>Max output jitter (peak-to-peak)</td>
<td></td>
</tr>
<tr>
<td>Random jitter</td>
<td></td>
</tr>
<tr>
<td>Deterministic jitter</td>
<td></td>
</tr>
<tr>
<td>Duty Cycle Distortion</td>
<td></td>
</tr>
<tr>
<td>Total jitter</td>
<td></td>
</tr>
</tbody>
</table>

Adjust applicable Table-85-4 transmitter specifications at TP0 to specify TP2.
802.3ba CR4 and CR10
Return Loss
Comment#663
Contributors

• Chris DiMinico, MC Communications
• Tom Palkert, Luxtera
RL 802.3ba return loss proposal

•Draft 1.1

\[
\text{Return Loss}(f) \geq 10 \text{ dB } \text{TBD}
\]

for \(100 \text{ MHz} \leq f < 4000 \text{ (TBD) MHz} \).

\[
\text{Return Loss}(f) \geq 10 - 10 \times \log_{10}\left(\frac{f}{4000 \text{ (TBD)}}\right) \text{ dB } \text{TBD}
\]

for \(4000 \text{ (TBD) MHz} \leq f \leq 10000 \text{ MHz} \).

•Draft 1.1- comment

\[
\text{Re } \text{turn Loss} (f) \geq 10 \quad \text{Re } \text{turn Loss}(f) \geq 10 - 7 \times \log\left(\frac{f}{1250}\right)
\]

for \(100 \text{ MHz} \leq f < 1250 \text{ MHz} \)

for \(1250 \text{ MHz} \leq f \leq 10000 \text{ MHz} \)
### E.4 SFP+ Passive Direct Attach Cable Assembly Specifications

Passive direct attach cables are tested with a pair of module Compliance Boards at compliance point B’ and C’. SFP+ passive cable assemblies need to meet specification in Table 37.

#### Table 37 10GSP+Cu Cable Assembly Specifications at B’ and C’

<table>
<thead>
<tr>
<th>Parameter - C’ (Cable Output)</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Target</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Ended Input and Output Voltage Tolerance</td>
<td>Vcm</td>
<td>See 1</td>
<td>-0.3</td>
<td>4.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output AC Common Mode Voltage</td>
<td>dWDP</td>
<td>See 2, 9, E.4.1, E.4.2, and D.14.2</td>
<td>13.5</td>
<td>mV (RMS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference Waveform Distortion Penalty</td>
<td>dVMA</td>
<td>See 9, D.5, E.4.4</td>
<td>6.75</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMA Loss</td>
<td>L</td>
<td>See 9, D.5, E.4.4</td>
<td>4.5</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMA Loss to Ground Ratio</td>
<td>LGR</td>
<td>See 9, E.4.1, E.4.4</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differential Output/Input Reflection Coefficient</td>
<td>SDDxx</td>
<td>0.01-4.1 GHz</td>
<td>See 5</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.1-11.1 GHz</td>
<td>See 6</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Mode Output/Input Reflection Coefficient</td>
<td>SCCxx</td>
<td>0.01-2.5 GHz</td>
<td>See 10</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5-11.1 GHz</td>
<td>See 11</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Parameter - B’ (Input Test Conditions)

<table>
<thead>
<tr>
<th>Parameter - B’ (Input Test Conditions)</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Target</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input AC Common Mode Voltage</td>
<td>Vcm</td>
<td>See 1, D.15.3</td>
<td>12</td>
<td>mA (RMS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal Rise and fall time</td>
<td>Trtf</td>
<td>See D.6</td>
<td>34</td>
<td>ps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crosstalk Source Rise/Fall time (20% to 80%)</td>
<td>Tr, Tff</td>
<td>See D.6</td>
<td>34</td>
<td>ps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crosstalk Source Amplitude Differential (p-p)</td>
<td>WDP1</td>
<td>700</td>
<td>mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>See 8</td>
<td>2.4</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. When input common mode voltage is 12.0 mA RMS and when input rise and fall times are 34ps and the amplitude is the max amplitude allowed by Table 12.
2. Defined with reference receiver with 14 T/2 spaced FFE taps and 5 T spaced DFE taps see Appendix G.
3. VMA loss is the ratio of VMA measured at input and output, respectively.
4. Reference differential impedance is 100 Ω. The dB value listed here are the same as dBc.
5. Reflection Coefficient given by equation SDDxx(dB) = 0.12 + 2.5*SQRT(3), with f in GHz.
6. Reflection Coefficient given by equation SDDxx(dB) = 0.12 + 3.13*log10(f/(5.5)), with f in GHz.
7. Common mode reference impedance is 25 Ω. The dB value listed here are the same as dBc.
8. Adjust DDI and/or DDPWS by adjusting pre-emphasis until the target WDP1 is achieved.
9. With input test condition given by parameters B’ given in this table.
10. Reflection coefficient given by equation SCC22(dB) = -0.12 + 2.8*f with f in GHz.
11. Reflection coefficient given by equation SCC22(dB) = -0.2 + 0.08*f, with f in GHz.
802.3ba RL proposal and SFP+ 3.2

- 0.5m QSFP cable assembly 24 AWG
- SFP+ Draft 3.2
- RX1
- RX2
- RX3
- RX4
- Tx1
- Tx2
- Tx3
- Tx4

CR4 and CR10 RL- 7 dB slope @1250 MHz
802.3ba channel ICR comment#301
Contributors

• Chris DiMinico, MC Communications
• Hiroshi Takatori, PhyCore Technology
Basis of 2.5 dB ICR allocation: IEEE Std 802.3ap™-2007 - 69B.4.6.4 Insertion loss to crosstalk ratio (ICR)

It is recommended that $ICR_{fit}$ be greater than or equal to $ICR_{min}$ as defined by Equation (69B–24).

$$ICR_{fit}(f) \geq ICR_{min}(f) = 23.3 - 18.7 \log_{10} \left( \frac{f}{5 \text{ GHz}} \right)$$  \hspace{1cm} (69B–24)

for $f_a \leq f \leq f_b$. $ICR_{fit}$ accounts for the worst-case differences in characteristics (e.g., amplitude, transition times) between the victim and aggressor transmitters. It also assumes a 3 dB signal-to-noise ratio penalty related to insertion loss deviation.

Add equation: $ICR_{fit}(f) \geq ICR_{min}(f) = 23.3 - 18.7 \times \log((f \times 10^6)/(5 \times 10^9)) - 2.5$ (TBD) dB

Note: 2.5 dB of the 3 dB signal-to-noise ratio penalty related to insertion loss deviation embodied in 802.3ap ICRmin is applied as 2.5 dB ICRmin margin to account for reduction in ILD penalty for CR4 and CR10
Comment # 457
Add cable assembly ILD specifications to limit cable assembly ILD. Add TBD to equation as contributions from IL and power sum crosstalk to ICR under consideration.

The cable assembly insertion loss deviation is the difference between the cable insertion loss and the fitted insertion loss determined using Equation (85-x).

\[
ILD(f) = IL(f) - IL_{fitted}(f)
\]

The ILD shall be within the region bounded by the following equations:

\[
ILD_{\text{max}} = 0.7(TBD) + 0.2(TBD) \times 10^{-9}(f \times 10^6) \quad \text{TBD dB}
\]

\[
ILD_{\text{min}} = -0.7(TBD) - 0.2(TBD) \times 10^{-9}(f \times 10^6) \quad \text{TBD dB}
\]

1000 MHz ≤ f ≤ 6000 MHz
802.3ap ILD vs CR4 and CR10  ILD 0.5m and 10m cable assembly

\[ KR_{ILD}(f) \leq KR_{ILD_{\max}}(f) = 1.0 + 0.5 \times 10^{-9} \times f \text{ dB} \]

\[ KR_{ILD}(f) \geq KR_{ILD_{\min}}(f) = -1.0 - 0.5 \times 10^{-9} \times f \text{ dB} \]
### Supporting analysis

<table>
<thead>
<tr>
<th>PCB per end</th>
<th>PCB total</th>
<th>TP0 - TP5 (dB)</th>
<th>SNR (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2”</td>
<td>4”</td>
<td>24.9</td>
<td>21.2</td>
</tr>
<tr>
<td>4”</td>
<td>8”</td>
<td>27.5</td>
<td>20.7</td>
</tr>
<tr>
<td>6”</td>
<td>12”</td>
<td>29.5</td>
<td>19.7</td>
</tr>
<tr>
<td>8”</td>
<td>16”</td>
<td>32.3</td>
<td>19.0</td>
</tr>
<tr>
<td>10”</td>
<td>20”</td>
<td>34.8</td>
<td>18.0</td>
</tr>
</tbody>
</table>
PhyCore simulations

SNR = 19.0dB (Linear EQL + 5tap DFE)
BER = $7.4 \times 10^{-19}$

Data Rate: 10.3125Gbps
10m cable + QSFPs + 8"PCB x 2
1.5ps rms jitter + BGN + Crosstalk

Transmitter
Linear EQL
DFE EYE

PhyCore Simulation

802.3ba – CR4 and CR10
Backup material
802.3ba IL allocation

<table>
<thead>
<tr>
<th>Description</th>
<th>dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum PCB insertion loss at 5.15625 GHz (4 in Amax) – TP0 to TP1</td>
<td>2.4</td>
</tr>
<tr>
<td>Maximum connector insertion loss at 5.15625 GHz – TP1 to TP2</td>
<td></td>
</tr>
<tr>
<td>Maximum cable assembly insertion loss at 5.15625 GHz – TP1 to TP4</td>
<td>21.55</td>
</tr>
<tr>
<td>Maximum channel insertion loss at 5.15625 GHz – TP0 to TP5</td>
<td>26.30</td>
</tr>
</tbody>
</table>
$802.3ba$ IL allocation

\[
IL_{pcb}(f) \leq IL_{pcb}(f) = Tx_{-}pcb + Rx_{-}pcb
\]

\[
IL_{pcb}(f) \leq IL_{pcb}(f) = (0.2032) \times \left[ 20 \times \log_{10}(e) \times \left( b_1 \sqrt{f} + b_2 f + b_3 f^2 + b_4 f^3 \right) \right]
\]

\[
IL_{channel}(f) \leq IL_{channel}(f) = IL_{cable \_assembly} + Tx_{-}pcb + Rx_{-}pcb
\]

\[
IL_{cable \_assembly}(f) \leq 0.192749 \times \sqrt{f} + 0.001494 \times f
\]

$100 \text{ MHz} \leq f \leq 6000 \text{ MHz}$