CDR Lock Time Study

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Test procedure

• Connect channel between both GBICs such that a BER of $10^{-4}$ exists from Tx of GBIC 2 to Rx of GBIC 1 while GBIC 2 is transmitting repeating pattern:
  • /-K28.5/+D30.7/ (low frequency content, all bits
  • /+K28.5/-D30.7/ transition on output at each clock)

• Place SERDES 1 in loopback with comma detect off while transmitting repeating pattern:
  • /-D21.5/ (high frequency square wave, constant SERDES output on each clock)

• Remove SERDES 1 from loopback and measure time until data from GBIC 2 is present on output of SERDES 1.
Test Procedure

• Repeat multiple runs on each channel to capture statistical nature of errors, phase, and lock time

• Repeat for channels with different BER (10e-4, 10e-6, 10e-8…)
## Data Capture Example

<table>
<thead>
<tr>
<th>Line #</th>
<th>Be4</th>
<th>Rx 10bCode</th>
<th>After</th>
<th>CG Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+</td>
<td>0111110111</td>
<td>+</td>
<td>K17.7; Invalid(0111110111)</td>
</tr>
<tr>
<td>2</td>
<td>+</td>
<td>1000111101</td>
<td>+</td>
<td>-D17.4; RD Error (1000111101)</td>
</tr>
<tr>
<td>3</td>
<td>+</td>
<td>1100001110</td>
<td>+</td>
<td>K28.0; Invalid(1100001110)</td>
</tr>
<tr>
<td>4</td>
<td>+</td>
<td>1111100011</td>
<td>+</td>
<td>D31.3; Invalid(1111100011)</td>
</tr>
<tr>
<td>5</td>
<td>+</td>
<td>0011111010</td>
<td>+</td>
<td>-K28.5; RD Error (0011111010)</td>
</tr>
<tr>
<td>6</td>
<td>+</td>
<td>1000111110</td>
<td>+</td>
<td>D17.7; Invalid(1000111110)</td>
</tr>
<tr>
<td>7</td>
<td>+</td>
<td>1100000101</td>
<td></td>
<td>+K28.5</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>0111100001</td>
<td></td>
<td>-D30.7</td>
</tr>
<tr>
<td>9</td>
<td>-</td>
<td>0011111010</td>
<td>+</td>
<td>-K28.5</td>
</tr>
<tr>
<td>10</td>
<td>+</td>
<td>1000011110</td>
<td>+</td>
<td>+D30.7</td>
</tr>
<tr>
<td>11</td>
<td>+</td>
<td>1100000101</td>
<td></td>
<td>+K28.5</td>
</tr>
</tbody>
</table>
GBIC#1 10e-12 BER Histogram

CDR lock time with 10e-12 BER (400 samples)

Number of samples vs. CDR lock time (10s of bit times)
GBIC#1 10e-12 BER statistics

- 400 samples
- Min of less than 10 bit times
- Max of 210 bit times (170ns)
- Mean of 6 bit times (5ns)
- Standard deviation of 25 bit times (20ns)
GBIC#1 10e-8 BER Histogram
GBIC#1 10e-8 BER statistics

- 400 samples
- Min of less than 10 bit times
- Max of 670 bit times (540ns)
- Mean of 50 bit times (40ns)
- Standard deviation of 100 bit times (80ns)
GBIC#1 10e-4 BER Histogram
GBIC#1 10e-4 BER statistics

• 400 samples
• Min of less than 10 bit times
• Max of 810 bit times (650ns)
• Mean of 60 bit times (50ns)
• Standard deviation of 100 bit times (80ns)
GBIC#2 10e-12 Histogram
GBIC#2 10e-12 BER statistics

- 400 samples
- Min of less than 10 bit times
- Max of 200 bit times (160ns)
- Mean of 4 bit times
- Standard deviation of 20 bit times (16ns)
GBIC#2 10e-4 Histogram
GBIC#2 10e-4 BER statistics

- 400 samples
- Min of less than 10 bit times
- Max of 690 bit times (550ns)
- Mean of 75 bit times (60ns)
- Standard deviation of 110 bit times (90ns)
Conclusions

- CDR lock time is impacted by BER
- CDR lock time is impacted by O/E conversion