Revisiting CX4 Transition Time Definition and Measurement
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Overview

- Goal
- Transition Time
- Model
- Results
- Conclusions & Recommendations
Objective

• Demonstrate that current rise/fall time measurement results depend on the pre-emphasis value
  • Phenomena that does not occur for established 20%-80% measurement procedure
Transition Time

• Defined in Clause 54.7.3.7 (P802.3ak D5.0)
  • “The rising edge transition time shall be between 60 and 130 ps as measured between the -0.35 to the 0.66 normalized levels as specified in 54.7.3.6. The falling edge transition time shall be between 60 and 130 ps as measured between the 0.35 to the -0.66 normalized levels as specified in 54.7.3.6.”

• In most applications it’s defined as the time between the 20%-80% of the transition swing
Model & Procedure

Simplified model for assessing rise time

- Procedure
  - Calculate $Y$
  - Perform Template Normalization
  - Measure Rise Time
    - According to standard
    - 20%-80% of normalized template
Results

• By nominal rise we refer to the transition time as measured according to 20%-80% of the transition swing
  • Note that normalization process does not change the 20%-80% transition times
Nominal Rise Time = 128psec

• All three templates are within the limits
Rise-Time “measurements”

<table>
<thead>
<tr>
<th>Pre-emphasis [%]</th>
<th>64</th>
<th>102</th>
<th>128</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>66</td>
<td>110</td>
<td>142</td>
</tr>
<tr>
<td>31</td>
<td>60</td>
<td>98</td>
<td>128</td>
</tr>
<tr>
<td>38</td>
<td>54</td>
<td>88</td>
<td>114</td>
</tr>
</tbody>
</table>

- Pre-emphasis affects the rise time measurement
- About 10% difference from nominal value at low and high pre-emphasis values
- Problematic cases are shaded
Conclusions & Recommendations

• Current CX4 definition causes unnecessary coupling between rise/fall time and pre-emphasis.

• Propose to revert to 20%-80% rise time definition
  • Basic idea is that for the normalized template we know that the starting point of the positive transition is at normalized voltage level of -0.69 to define the 20%-80% thresholds all that remains it to find the peak
  • Similarly for negative transition the starting point is 0.69
Rising Edge transition time - proposed definition

- The rising edge transition time shall be between 60 and 130 ps.
- The rising edge transition time will be measured by using the following procedure:
  1. Measure the peak normalized template between 0.5UI and 2.5UI - called $V_p$
  2. Compute the lower threshold of the positive transition
     $$\text{th}_{\text{low}}_p = -0.69 + 0.2(V_p + 0.69)$$
  3. Compute the upper threshold of the positive transition
     $$\text{th}_{\text{up}}_p = -0.69 + 0.8(V_p + 0.69)$$
  4. Measure the rising time of the normalized template transition from the lower to upper thresholds defined above.
Falling Edge transition time – proposed definition

- The falling edge transition time shall be between 60 and 130 ps.
- The falling edge transition time will be measured by using the following procedure:
  1. Measure the peak of the absolute of the normalized template between 5.5UI and 7.5UI - called $V_n$
  2. Compute the upper threshold of the negative transition
     $\text{th}_{\text{up}}_n= 0.69 - 0.2*(V_n + 0.69)$
  2. Compute the lower threshold of the negative transition
     $\text{th}_{\text{low}}_n= 0.69 - 0.8*(V_n + 0.69)$
  4. Measure the falling time of the normalized template transition from the upper to lower thresholds defined above.