6G SAS Reference TX & RX Termination Networks

Mike Jenkins
LSI Corp.
Objective

- Design termination networks to reasonably recreate worst case SDD11, SDD22, SCC11, SCC22, SCD11 & SCD22
But 1\textsuperscript{st}... where is this going?

- Three applications:
  1. Validation of channels
  2. Validation of TX
  3. Validation of RX
- 1\textsuperscript{st} two applications are software, but 3\textsuperscript{rd} application requires hardware implementation of reference TX
- Problem: lab equipment cannot emulate worst case return loss
Proposed Solution

• Since 3\textsuperscript{rd} application (RX validation) always uses 10 meter iPass cable, TX return loss affects far end waveform very little.

• Propose that termination networks be applied only to software ref. TX & RX
Return Loss Spec Format

\[
LF = \frac{tol}{2(2+tol)} \\
\approx \frac{tol}{2}
\]

\[
F_Z = \frac{tol}{2\pi RC (1+tol)} \\
\approx \frac{tol}{2\pi RC}
\]

\[
F_P = \frac{(2+tol)}{2\pi RC (1+tol)} \\
\approx \frac{1}{\pi RC}
\]
Model #1

\[ R_1 = R_1^* \parallel \text{Zo}, \quad R_2 = R_2^* \parallel \text{Zo}, \quad R_1 C_1 = R_2 C_2 = R_3 C_3 = \tau \]

\[ S_{11} = \left[ \frac{(2/\text{Zo}) \times \left( R_1 \parallel (R_2 + R_3) \right) - 1 - s\tau}{1+s\tau} \right] \]

\[ S_{12} = \left[ \frac{(2/\text{Zo}) \times \left( R_1 R_2 / (R_1 + R_2 + R_3) \right)}{1+s\tau} \right] \]

\[ S_{22} = \left[ \frac{(2/\text{Zo}) \times \left( R_2 \parallel (R_1 + R_3) \right) - 1 - s\tau}{1+s\tau} \right] \]

5 June 2007

T10/07-267r0
Normalizing resistors to \( Zo \): \( r_1 = R_1/Zo, \ r_2 = R_2/Zo, \ r_3 = R_3/Zo \)

\[
S_{11} = -[(1 - 2(r_1||(r_2+r_3))) + s\tau] / [1+s\tau]
\]

\[
S_{12} = [2(r_1r_2 / (r_1+r_2+r_3))] / [1+s\tau]
\]

\[
S_{22} = -[(1 - 2(r_2||(r_1+r_3))) + s\tau] / [1+s\tau]
\]

\[
S_{DNN} = [S_{11} + S_{22} - 2 S_{12}]/2
\]

\[
= -[(1 - r_3||(r_1+r_2)) + s\tau] / [1+s\tau]
\]

\[
S_{CCN} = [S_{11} + S_{22} + 2 S_{12}]/2
\]

\[
= -[(1 - [4r_1r_2+r_1r_3+r_2r_3]/[r_1+r_2+r_3]) + s\tau] / [1+s\tau]
\]

\[
S_{CDN} = [S_{11} - S_{22}]/2
\]

\[
= [ (r_1-r_2)r_3 / (r_1+r_2+r_3) ] / [1+s\tau]
\]
Model #1 Values

<table>
<thead>
<tr>
<th>r1</th>
<th>r2</th>
<th>r3</th>
<th>tau</th>
<th>R1*</th>
<th>R2*</th>
<th>R3</th>
<th>Zo</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.65</td>
<td>0.6</td>
<td>10</td>
<td>25</td>
<td>93</td>
<td>75</td>
<td>500</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model #1 Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
</tr>
<tr>
<td>SCC11</td>
</tr>
<tr>
<td>0.10</td>
</tr>
</tbody>
</table>

5 June 2007
Model #2

\[ \frac{ZoC_1}{2} = \tau_1 \]

\[ \frac{ZoC_2}{2} = \tau_2 \]

\[ S_{11} = -s\tau_1 / (1+s\tau_1) \]

\[ S_{12} = 0 \]

\[ S_{22} = -s\tau_2 / (1+s\tau_2) \]

\[ SDD_{nn} = SCC_{nn} = \frac{[S_{11} + S_{22}]}{2} \]

\[ SCD_{nn} = \frac{[S_{11} - S_{22}]}{2} \]
Model #2

Values

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
<th>tau1</th>
<th>tau2</th>
<th>Zo</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.5</td>
<td>50</td>
<td>12.5</td>
<td>50</td>
</tr>
</tbody>
</table>

pF pF ps ps ohms

GHz dB

SCC11 SDD11 SCD11

SCC11 Limit SDD11 Limit SCD11 Limit

5 June 2007