LVD SCSI Driver Proposal

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Adaptec
Existing Boundaries

- Test circuit (SPI-2 10.1.1):
  9.7 mA < Ia < 15.0 mA
  4.9 mA < In < 15.8 mA
  -0.9 mA < Ia - In < 7.5 mA
  This describes a diagonal band across a rectangular region.

- Algebraically derived minimum requirements:
  Ia >= 7.02 mA + .353 * In
  In >= 1.61 mA + .353 * Ia
  This describes a wedge-shaped region.
SPI-2 Test Circuit (10.1.1)
Algebraic Solution

Ia vs. In

Graph showing the relationship between Ia and In.
Overlay of Both Regions

I_a vs. I_n

In (mA) 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
I_a (mA) 0 1 2 3 4 5 6 7 8 9 10
Points of Interest

<table>
<thead>
<tr>
<th>Label</th>
<th>In (mA)</th>
<th>Ia (mA)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.7</td>
<td>8.7</td>
<td>Tip of wedge</td>
</tr>
<tr>
<td>B</td>
<td>7.6</td>
<td>9.7</td>
<td>Intersection of wedge and bottom edge of rectangle</td>
</tr>
<tr>
<td>C</td>
<td>15.8</td>
<td>9.7</td>
<td>Lower right-hand corner of rectangle</td>
</tr>
<tr>
<td>D</td>
<td>15.8</td>
<td>15.0</td>
<td>Upper right-hand corner of rectangle</td>
</tr>
<tr>
<td>E</td>
<td>6.9</td>
<td>15.0</td>
<td>Intersection of wedge and top edge of rectangle</td>
</tr>
</tbody>
</table>

- Consider region ABCDE.
- Point C fails in Kevin Gingerich’s spreadsheet model. Either move up or move left.
- Points B and E are unnecessarily strict. Eliminate B and move E to the left.
Points of Interest

<table>
<thead>
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<th>Ia (mA)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.7</td>
<td>8.7</td>
<td>Tip of wedge</td>
</tr>
<tr>
<td>C'</td>
<td>10.1</td>
<td>9.7</td>
<td>Rightmost working point on bottom edge of rectangle</td>
</tr>
<tr>
<td>C''</td>
<td>15.8</td>
<td>10.8</td>
<td>Lowest working point on right-hand edge of rectangle</td>
</tr>
<tr>
<td>D</td>
<td>15.8</td>
<td>15.0</td>
<td>Upper right-hand corner of rectangle</td>
</tr>
<tr>
<td>E'</td>
<td>4.8</td>
<td>15.0</td>
<td>Leftmost working point on top edge of rectangle</td>
</tr>
</tbody>
</table>

- Consider AC’DE’. Boundary includes 3 diagonals and one horizontal segment.
- AC’’DE’ requires one less diagonal segment and is therefore easier to specify.
- The spreadsheet model shows that all four corners of AC’DE’ or AC’’DE’ give sufficient assertion-to-negation and negation-to-assertion transitions under worst case conditions.
Modified Region of Operation

![Graph showing the modified region of operation with points A, B, C', D, and E'. The graph plots current (mA) against current (mA). The shaded area represents the modified region.]
Objection: 4:1 Voltage Ratio

- Need to meet receiver input balance requirements.
- Derive an additional boundary condition:
  
  \[ |V_N| \leq 4|V_+| \]
  
  \[-V_N \leq 4(V_N + (I_A + I_N)Z_L/2) \]
  
  \[5V_N + 2(I_A + I_N)Z_L \geq 0 \]

  \[5(I_NR_T/2 + V_B) \leq 2(I_A + I_N)Z_L \]

  \[I_A \geq 3.8 \text{ mA} + .69*I_N \]

- Similar derivation to ensure \(|V_A| \leq 4|V_-| \) gives:
  
  \[I_N \geq -2.9 \text{ mA} + .69*I_A \]

  or,

  \[I_A \leq 4.2 \text{ mA} + 1.45*I_N \]
Revised Region of Operation
New Boundaries

\[ I_A \geq 7.8 \text{ mA} + 0.19 \times I_N \] (AC”)

\[ I_N \leq 15.8 \text{ mA} \] (C”D)

\[ I_A \leq 15.0 \text{ mA} \] (DE’)

\[ I_N \geq 4.5 \text{ mA} + 0.02 \times I_A \] (E’A)

\[ I_A \geq 3.8 \text{ mA} + 0.69 \times I_N \] (receiver balance)

\[ I_N \geq -2.9 \text{ mA} + 0.69 \times I_A \]
Proposed Test Conditions

- Replace:
  \[ 416 \text{ mV} \leq V_A \leq 706 \text{ mV} \]
  with:
  \[ 309 \text{ mV} + 0.19 \times |V_N| \leq V_A \leq 706 \text{ mV} \]

- Replace:
  \[ 381 \text{ mV} \leq |V_N| \leq 977 \text{ mV} \]
  with:
  \[ 361 \text{ mV} + 0.02 \times V_A \leq |V_N| \leq 977 \text{ mV} \]

- Replace:
  \[ -277 \text{ mV} < |V_A| - |V_N| < 181 \text{ mV} \]
  with:
  \[ 91 \text{ mV} + 0.69 \times |V_N| \leq V_A \leq 113 \text{ mV} + 1.45 \times |V_N| \]
Further Improvements?

- Lowering the maximum termination resistance or the maximum bias voltage reduces the drive current requirement by about 0.5 to 1.0 mA. Minimum values for these parameters should not be changed.
- How much tightening of these parameters (if any) can be tolerated by terminator designers?