1.27mm Pitch
B2B® SMT Connector
8.00mm Mated Height

SIGNAL INTEGRITY SIMULATION AND MODELING

Rev. 1

www.advanced.com
Signal Integrity Data Reporting

At Advanced Interconnections Corporation, our Signal Integrity reporting method differs dramatically from the common industry practice of isolating the *aggressor* and *victim* terminals from each other by introducing dedicated ground terminals between them. We believe this method represents a theoretical, best-case, scenario that does not serve the needs of most systems engineers and circuit designers. An unrealistic number of connector terminals must be assigned to ground in order to achieve this scenario.

Our standard reporting practice is closely aligned with the decision-making processes of most systems engineers and circuit designers. The reported data addresses our customers I/O assignments (net-list) and helps them determine where to best run high-versus-low frequency signals through our connectors. As such, our reporting method represents a more practical net-list scenario. Utilizing our unbiased SPICE™ and IBIS™ files, system designers are able to create and/or debug their net-list quickly and accurately.
SI Modeling & Simulation Study

Simulation Setup

- The 1.27mm pitch, 8mm stack height was setup in a Agilent ADS Multi-Layer Library.
- A pin-out of 3 rows and 4 columns was assigned from a 4x4 array:

<table>
<thead>
<tr>
<th></th>
<th>GND</th>
<th>GND</th>
<th>GND</th>
<th>GND</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1+</td>
<td>S1-</td>
<td>S2+</td>
<td>S2-</td>
<td></td>
</tr>
<tr>
<td>GND</td>
<td>GND</td>
<td>GND</td>
<td>GND</td>
<td></td>
</tr>
</tbody>
</table>

- A total of 12 sections were implemented, 6 for the female receptacle and 6 for the male pin.
  - Each section was implemented using 3 separate horizontal rows, which then were combined together into the 3x4 array using the ADS “combine 3 into 1” element.
  - The material properties of the plastic bodies were as follows:
    - Male: $\varepsilon_r = 3.7$, $\tan \delta = 0.005$; and Female: $\varepsilon_r = 3.2$, $\tan \delta = 0.009$.
    - Air was defined as $\varepsilon_r = 1$, $\tan \delta = 0$.
  - The Effective Er (composite value = plastic + air) of Receptacle_plastic_2 was calculated to be $\text{Eff}_\varepsilon = 2.75$, $\tan \delta = 0.005$.

Leads added to stabilize signal launch were de-embedded.

De-embedded Waveguide Ports
Simulation Results

The test and measurement tasks were completed and the recommended Operational Bandwidth for the Socket Adapter System is as follows:

- **Differential:** DC to 1.3 GHz @ -15dB and ~0.8 to 1.4 Gbit/sec.
- **Differential:** DC to 2.5 GHz @ -10dB and ~1.6 to 2.6 Gbit/sec.
- **Single-ended:** DC to 2.1 GHz @ -15dB and ~1.3 to 2.2 Gbit/sec.
- **Single-ended:** DC to 4.6 GHz @ -10dB and ~2.9 to 4.9 Gbit/sec.
Simulation Results—continued

- Differential Eye Diagrams were successfully formed at 5 Gbits/sec., with Jitter at 5psec and 11% eye closure.
  - The eye opening sustains a Data Mask with a voltage swing of ±175mV @ 100psec period.

- Single-ended Eye Diagrams were successfully formed at 5 Gbits/sec., with Jitter at 6psec and 10% eye closure.
  - The eye opening sustains a Data Mask with a voltage swing of ±125mV @ 140psec period.
### SI Modeling & Simulation Study

Simulation Results—continued

<table>
<thead>
<tr>
<th></th>
<th>Return Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(S\omega,\theta)</td>
</tr>
<tr>
<td>Differential</td>
<td>(S1,1) and (S2,2)</td>
</tr>
<tr>
<td>(Terminals S1+, S1-)</td>
<td>-15.0dB @ 1.3 GHz</td>
</tr>
<tr>
<td></td>
<td>-10.0dB @ 2.5 GHz</td>
</tr>
<tr>
<td></td>
<td>(S2,1)</td>
</tr>
<tr>
<td></td>
<td>-0.15dB @ 1.3 GHz</td>
</tr>
<tr>
<td></td>
<td>-0.50dB @ 2.5 GHz</td>
</tr>
<tr>
<td></td>
<td>Zo @ 200 psec</td>
</tr>
<tr>
<td></td>
<td>(10-90%)</td>
</tr>
<tr>
<td></td>
<td>80.0Ω</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Insertion Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(S\phi,\beta)</td>
</tr>
<tr>
<td>Single-ended</td>
<td>(S1,1) and (S2,2)</td>
</tr>
<tr>
<td>(Terminals S1+)</td>
<td>-15.0dB @ 3.3 GHz</td>
</tr>
<tr>
<td></td>
<td>-10.0dB @ 6.2 GHz</td>
</tr>
<tr>
<td></td>
<td>(S2,1)</td>
</tr>
<tr>
<td></td>
<td>-0.40dB @ 3.3 GHz</td>
</tr>
<tr>
<td></td>
<td>-0.75dB @ 6.2 GHz</td>
</tr>
<tr>
<td></td>
<td>45.1Ω</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Insertion Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(S\phi,\beta)</td>
</tr>
<tr>
<td>Single-ended</td>
<td>(S3,3) and (S4,4)</td>
</tr>
<tr>
<td>(Terminals S1-)</td>
<td>-15.0dB @ 2.1 GHz</td>
</tr>
<tr>
<td></td>
<td>-10.0dB @ 4.6 GHz</td>
</tr>
<tr>
<td></td>
<td>(S4,3)</td>
</tr>
<tr>
<td></td>
<td>-0.40dB @ 2.1 GHz</td>
</tr>
<tr>
<td></td>
<td>-1.00dB @ 4.6 GHz</td>
</tr>
<tr>
<td></td>
<td>43.8Ω</td>
</tr>
</tbody>
</table>

- A **Return Loss** at -15dB (~18% Reflection) is the normally accepted industry standard. Most applications will tolerate data at -10 dB (~32% Reflection), however in this instance, performance safety margins may be increased by *de-rating* the connectors Operational Bandwidth and Data Rate.

- A **Insertion Loss** at -3dB (~50% of applied Power & ~71% of applied Voltage arrives at the Output Port) is the normally accepted industry standard.

- An Effective Impedance of 100Ω ±10Ω for Differential and 50Ω ±5Ω for Single-ended is the normally accepted industry guideline. De-rating the signal input risetime will improve the above Zo values.
Simulation Results– continued

<table>
<thead>
<tr>
<th></th>
<th>NeXT @ 200 psec (10-90%)</th>
<th>FeXT @ 200 psec (10-90%)</th>
<th>Eye-Diagram @ 5 Gbit/sec</th>
<th>Eye-Diagram @ 5 Gbit/sec with 6 Gbit/sec Aggressor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Differential</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Terminals S1+, S1-)</td>
<td>1.95%</td>
<td>1.45%</td>
<td>Peak-to-Peak Jitter = 4 psec Eye-Closure = 9%</td>
<td>Peak-to-Peak Jitter = 5 psec Eye-Closure = 11%</td>
</tr>
<tr>
<td><strong>Single-ended</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Terminals S1-)</td>
<td>5.18%</td>
<td>1.35%</td>
<td>Peak-to-Peak Jitter = 1 psec Eye-Closure = 3%</td>
<td>Peak-to-Peak Jitter = 6 psec Eye-Closure = 10%</td>
</tr>
</tbody>
</table>

• **A NeXT at 5% maximum is the normally accepted industry standard.** Shown above are worst case values for unshielded adjacent terminals. Under these conditions the NeXT differential results are acceptable.

• **A FeXT at 2% maximum is the normally accepted industry standard.** Shown above are worst case values for unshielded adjacent terminals. Under these conditions differential FeXT results are acceptable and the single-ended FeXT results are acceptable.

• **A successful Eye-opening was created at 5 Gbit/sec and is favorable as this data rate is well within the Operational Bandwidths recommended for this connector system.** See note below.

**NOTE:** The connector’s transmit Data Mask can be defined to quantify the effective performance of the eye formation. For a Differential data mask, the total voltage equals 35% of the eye’s applied peak-to-peak voltage, (1V in this report), and its period equals 50% of the Eye Interval, (200psec in this report). For a Single-ended data mask, the total voltage equals 50% of the eye’s applied peak-to-peak voltage, (500mV in this report), and its period equals 70% of the Eye Interval, (200psec in this report). The Eye Interval = 1/Eye Data Rate = 1/5E9 = 200psec in this report. Normally, Maximum allowable Jitter = 5% and Maximum allowable Eye-Closure = 12%.
Differential Return Loss

Plot Range: DC to 5 GHz

-15dB @ 1.30GHz
-10dB @ 2.45GHz
Differential Insertion Loss

Plot Range: DC to 5 GHz

-0.15dB @ 1.30GHz
-0.50dB @ 2.45GHz
Single-ended Return Loss for S1+

Plot Range: DC to 20 GHz

-15dB @ 3.30GHz
-10dB @ 6.20GHz

dB(S(2,2))
dB(S(1,1))
Single-ended Return Loss for S1+

Plot Range: DC to 5 GHz

-15dB @ 3.30GHz
-10dB @ 6.20GHz
Single-ended Return Loss for S1-

Plot Range: DC to 20 GHz

dB(S(4,4))

dB(S(3,3))

-15dB @ 2.10GHz

-10dB @ 4.60GHz
Single-ended Return Loss for S1-

Plot Range: DC to 5 GHz

-15dB @ 2.10GHz
-10dB @ 4.60GHz
Single-ended Insertion Loss for S1+

Plot Range: DC to 20 GHz

-0.40dB @ 3.30GHz
-0.75dB @ 6.20GHz
**Single-ended Insertion Loss for S1-**

Plot Range: DC to 20 GHz

-0.40dB @ 2.10GHz
-1.00dB @ 4.60GHz
Single-ended Insertion Loss for S1-

Plot Range: DC to 5 GHz

\[ dB(S(4,3)) \]

\[
\begin{align*}
-0.40\text{dB} @ 2.10\text{GHz} \\
-1.00\text{dB} @ 4.60\text{GHz}
\end{align*}
\]
Differential Impedance Profile

Simultaneous Plots at **200 psec** risetime (10-90%)
Simultaneous Plots at **200 psec** risetime (10-90%)  
**S1+ (Zsp Edge Terminals) vs. S1- (Zsn Interior Terminals)**

- **Zsp** line: 45.1 Ω
- **Zsn** line: 43.8 Ω
Differential Near-end Crosstalk (NeXT)

Percent Differential NeXT @ 200ps risetime (10-90%)

1.95%

time, ns e c
Differential Far-end Crosstalk (FeXT)

Percent Differential FeXT @ 200ps risetime (10-90%)
Single-ended Near-end Crosstalk (NeXT)

Percent Single-ended NeXT @ 200ps risetime (10-90%)

100*xne[2][0:1000]

5.18%
Single-ended Far-end Crosstalk (FeXT)

Percent Single-ended FeXT @ 200ps risetime (10-90%)

1.35%
Differential Eye-Diagram

Differential Eye-Diagram

Eye Opening @ 5 Gbit/sec.

Peak-to-peak jitter is 4 psec and Eye-Closure is 9%

Eye (voutp-voutn, 2.5e9)

time, psec
Differential Eye-Diagram w/Aggressor

Eye Opening @ 5 Gbit/sec with a 6 Gbit/sec Aggressor

Peak-to-peak jitter is 5 psec and Eye-Closure is 11%

±175mV
@ 100psec
Data Mask
Eye Opening @ 5 Gbit/sec.

Peak-to-peak jitter is 1 psec and Eye-Closure is 3%
Single-ended Eye-Diagram w/Aggressor

Eye Opening @ 5 Gbit/sec with a 6 Gbit/sec Aggressor

Peak-to-peak jitter is 6 psec and Eye-Closure is 10%

±125mV
@ 140psec
Data Mask