Attenuation Data for Fast-160
(Ultra320) SCSI
T10/00-349r0

Seagate - Bruce Manildi
Huntington Beach, CA
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SCSI Sub-System Setup for Measurements

- Actual SCSI driver (w/offset, asymmetry, process variations, etc) driving all lines to operating drives with a pseudo-random pattern (i.e. w/ crosstalk and noise).
- Backplanes and cables (longest) supplied by Customers for actual systems in the field or in development (w/some exceptions, for reference only)
- Actual SCSI auxiliary system components (Terminators, connectors, etc)
### Table 11 - Attenuation requirements for SCSI cable media

<table>
<thead>
<tr>
<th>Distance between SCSI bus terminators (meters)</th>
<th>Attenuation per meter maximum (dB) at 200 MHz</th>
<th>Attenuation of length equivalent to terminator to terminator distance maximum (dB) at 200 MHz</th>
<th>Distances are consistent with these minimum size conductors when used with high quality dielectrics</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 9</td>
<td>0.63</td>
<td>6</td>
<td>0.0324 mm² (32 AWG) solid/ 0.05092 mm² (30 AWG) stranded</td>
<td>multiple loads allowed</td>
</tr>
<tr>
<td>0 to 12</td>
<td>0.48</td>
<td>6</td>
<td>0.05092 mm² (30 AWG) solid/ 0.08042 mm² (28 AWG) stranded</td>
<td>multiple loads allowed</td>
</tr>
<tr>
<td>&gt;12 to 25</td>
<td>0.48</td>
<td>12</td>
<td>0.05092 mm² (30 AWG) solid/ 0.08042 mm² (28 AWG) stranded</td>
<td>point to point only</td>
</tr>
</tbody>
</table>

Note: Both the per meter and the length equivalent to the terminator to terminator spacing requirements shall be simultaneously met.
## Tables 9 & 10

### Table 9 - SE and LVD local transmission line impedance

<table>
<thead>
<tr>
<th>Cable construction</th>
<th>Local SE transmission line impedance (note 2)</th>
<th>Local differential transmission line impedance (note 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>All</td>
<td>84 Ohms (78 Ohms) (note 3)</td>
<td>96 Ohms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>110 Ohms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>135 Ohms</td>
</tr>
</tbody>
</table>

Note:
1. All values are measured by time domain reflectometry
2. Ideally one design will meet both SE and differential criteria
3. If SCSI loads attached to the cable media are separated by more than 1.0 m use the value of 78 Ohms.

### Table 10 - Cable media capacitance limits

<table>
<thead>
<tr>
<th></th>
<th>Minimum capacitance</th>
<th>Maximum capacitance</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE</td>
<td>30 pF/m</td>
<td>66 pF/m</td>
<td>100 kHz and 1 MHz</td>
</tr>
<tr>
<td>Differential</td>
<td>26 pF/m</td>
<td>46 pF/m</td>
<td>100 kHz and 1 MHz</td>
</tr>
</tbody>
</table>
Cable Losses Vs. Frequency

Cable Loss vs Frequency

-18.0
-16.0
-14.0
-12.0
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
0 50 100 150 200

Frequency (MHz)

Loss (dB)

-18.0
-16.0
-14.0
-12.0
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0

12 M Amph TnF
25 M Amph TnF
12 M Amph DB7
12 M Mad Shield
Rnd
Specification
25 M Hit Shld Rnd
10 M Hitachi ribbon cable loss Vs. Frequency
Test Chip Driving 25 M Hitachi Rnd - Term only

DB9 Hitachi Round 25M Terminator only - Test Chip

Amplitude (V)

Time (nanosec)
Test Chip Driving 25 M Hitachi Rnd - Term only

DB0 Hitachi Round 25M Terminator only - Test Chip

Amplitude (V)

Time (nanosec)
Test Chip Driving 10 M TN’F - Term only

DB9 Amph TN’F 10M Terminator only - Test Chip

Amplitude (V)

Time (nanosec)
Test Chip Driving 10 M TN’F - Term only

DB0 Amph TN’F 10M Terminator only - Test Chip

Amplitude (V)

Time (nanosec)
Vendor C - 10 slot backplane w/12 M Madison (round)

Slot 1(4) DB0 12M Madison Round - Test Chip

Amplitude (V)

Time (nanosec)
Vendor C - 10 slot backplane w/12 M Madison (round)

Slot 1(4) DB9 12M Madison Round - Test Chip

Time (nanosec) vs Amplitude (V) graph showing waveforms.
Vendor C - 10 slot backplane w/10 M Laminated

Slot 1(4) DB0 10 M Lam - Test Chip

Amplitude (V)

Time (nanosec)
Vendor C - 10 slot backplane w/10 M Laminated

Slot 1(4) DB9 10 M Lam - Test Chip

Amplitude (V)

Time (nanosec)
Vendor C - 10 slot backplane w/ 12 M Madison (round)

Slot 10(9) DB0 12M Madison Round - Test Chip

- Amplitude (V)
- Time (nanosec)
Vendor C - 10 slot backplane w/12 M Madison (round)

Slot 10(9) DB9 12M Madison Round - Test Chip

Amplitude (V)

Time (nanosec)
Vendor C - 10 slot backplane w/10 M Laminated

Slot 10(9) DB0 10 M Lam - Test Chip

-0.6
-0.4
-0.2
0
0.2
0.4
0.6

-0.2
-0.4
-0.6
0
50
100
150
200

Time (nanosec)

Amplitude (V)
Vendor C - 10 slot backplane w/10 M Laminated

Slot 10(9) DB9 10 M Lam - Test Chip

Amplitude (V)

Time (nanosec)
DB0 @ Slot 3 Backplane E w/ 12 m Madison Round cable - Test Chip

Amplitude (V)

Time (nanosec)
DB9 @ Slot 3 Backplane E Test Chip Driving

DB9 @ Slot 3 BackPlane E w/ 12 m Madison Round cable - Test Chip

Amplitude (V)

Time (nanosec)
DB0 @ Slot 3 BackPlane E w/ 40" TNF cable - Test Chip

Amplitude (V)

Time (nanosec)
DB9 @ Slot 3 Backplane E Test Chip Driving

DB9 @ Slot 3 BackPlane E w/ 40" TNF cable - Test Chip

Amplitude (V)

Time (nanosec)
DB9 @ Slot 3 Backplane E Test Chip Driving

DB9 @ Slot 3 BackPlane E w/ 10 m Hitachi B/W TN'F cable - Test Chip

Amplitude (V)

Time (nanosec)
Vendor long cable (40”), 10 slot, all slots

Frequency Dependent Amplitude Change

Amplitude Change (dB)

Slot Position

Seagate
First Pulse Amplitude Vs. DC (low freq.)

First Pulse Amplitude Relative to DC

% of Low Freq. Amplitude

80 85 90 95 100 105

1 2 3 4 5 6 7 8 9 10

Slot Position

Seagate
Information the way you want it™
### Summary

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Attenuation</th>
<th>$V_{iso}/V_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>25m round, point-to-point, term. Only</td>
<td>-4.2 dB</td>
<td>0.73</td>
</tr>
<tr>
<td>10m flat, point-to-point, terminator only</td>
<td>-4.5 dB</td>
<td>0.71</td>
</tr>
<tr>
<td>10m round, 10-slot bp, @slot 4</td>
<td>-4.3 dB</td>
<td>0.74</td>
</tr>
<tr>
<td>10m laminated ribbon, 10-slot bp, @slot 4</td>
<td>-6.0 dB</td>
<td>0.64</td>
</tr>
<tr>
<td>10m round, 10-slot bp, @slot 9</td>
<td>-7.2 dB</td>
<td>0.53</td>
</tr>
<tr>
<td>10m laminated ribbon, 10-slot bp, @slot 9</td>
<td>-10.9 dB</td>
<td>0.42</td>
</tr>
<tr>
<td>3.75m ribbon, 5-slot bp, @slot 3</td>
<td>-4.5 dB</td>
<td>0.72</td>
</tr>
<tr>
<td>10m round, 5-slot bp, @slot 3</td>
<td>-7.7 dB</td>
<td>0.69</td>
</tr>
<tr>
<td>10m laminated ribbon, 5-slot bp, @slot 3</td>
<td>-5.0 dB</td>
<td>0.58</td>
</tr>
</tbody>
</table>

*Note: $V_{iso}$ is measured at the peak of the ‘first pulse’, not in the middle where data is nominally clocked.*
## Summary

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Attenuation</th>
<th>Viso/Vs (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25m round, point-to-point, term. only</td>
<td>-3.1 dB</td>
<td>0.73</td>
</tr>
<tr>
<td>10m flat, point-to-point, terminator only</td>
<td>-1.0 dB</td>
<td>0.90</td>
</tr>
<tr>
<td>12m round, 10 slot bp @ slot position 4(^{(2)})</td>
<td>-2.9 dB</td>
<td>0.78</td>
</tr>
<tr>
<td>10m lam. ribbon, 10-slot bp @ slot 4</td>
<td>-2.4 dB</td>
<td>0.80</td>
</tr>
<tr>
<td>12m round, 10 slot bp @ slot pos. 9 (^{(2)})</td>
<td>-3.7 dB</td>
<td>0.76</td>
</tr>
<tr>
<td>10m lam. ribbon, 10 slot bp @ slot 9</td>
<td>-2.7 dB</td>
<td>0.83</td>
</tr>
<tr>
<td>12m round, 5-slot bp @ slot position 3 (^{(2)})</td>
<td>-2.2 dB</td>
<td>0.84</td>
</tr>
<tr>
<td>10m lam. ribbon, 5-slot bp @ slot 3</td>
<td>-3.1 dB</td>
<td>0.76</td>
</tr>
</tbody>
</table>

**Note:**
1. Viso is measured in the middle of the ‘first pulse’ where data is normally clocked
2. We used 12 M instead of 10 M round - 20% additional degradation
Conclusions

- Actual subsystems which include backplanes with short ribbon cables do not need pre-compensation or AAF.
- Subsystems which include long cables need some sort of frequency compensation.
- No actual subsystem of any type had a high frequency loss of greater than 30% including noise, crosstalk and process variations.
Invitational Challenge

- We set up our lab to facilitate these kind of measurements - and partially automated the collection of data and its presentation
  - First Pulse
  - Frequency attenuation
  - Cable measurements

- We invite you to use our lab
  - Send us your materials and we will measure
  - Come with your materials and we can measure together
  - (If Quantum - we’ll set it up in the park next door)