Four SSC Options Considered

1) No SSC
2) Down Spread 5000 ppm
3) Center spread +/- 2500 ppm
4) Up spread 5000 ppm

Need to consider the Advantages and Disadvantages of Each Option

Assumptions / Background

• SSC is Highly Desirable and Beneficial in solving EMI issues (HP 06-064r2)
• 6G SATA will most likely remain Down Spread 0 → -5000ppm (Infineon 06-192r0)
• Center Spread has implementation advantages (PMC 06-193r0)
• Multiplexing Legacy drives and Down Spread SSC of the uplink will not work (May Phy. Meeting Discussion)
  • 6G Links with 5000ppm Down Spread SSC do not have the throughput to support two legacy 3G SAS Devices
• Expanders will remove and or insert aligns as necessary

Reference Numbers

• SATA SSC Down Spread Fc → Fc – 5000ppm
• SATA Align Density 2/256 → Fc – 7812ppm (Sufficient to support 5000ppm down spread SSC and Rate matching)
• SAS Align Density 2/4096 → Fc – 488ppm (Insufficient to support 5000ppm down spread)
• SAS Reference Clock Fc +/- 100ppm
• SATA Reference Clock Fc +/- 350ppm
Worst Case Buffer Sizing w/ Sawtooth SSC

- Largest Buffer required when Rx and Tx are 180 out of phase
- Rx at Highest Data Rate and Tx at Slowest Data Rate
- Integrate the frequency Difference to see the Buffer size

\[ \Delta T = \frac{K}{F_c(1 + \Delta F)} \]

\[ \Delta \text{bits} = \Delta F \cdot \Delta T \]

\[ \Delta \text{Words} = \frac{\Delta F \cdot \Delta T}{40} \]

Example: 6G 5000ppm Down Spreading @ 30KHz

- \( F_c = 6G - 2500 \text{ ppm} \)
- \( \Delta F = 2500 \text{ ppm} \cdot (6G - 2500 \text{ ppm}) = 14.96 \text{ MHz} \)
- \( \Delta T = \frac{1}{30K} = 33.3 \text{ us} \)
- \( \Delta \text{bits} = \Delta F \cdot \Delta T = 249.3 \text{ bits} \)
- \( \Delta \text{Words} = \frac{\Delta F \cdot \Delta T}{40} = 6.23 \text{ DWords} \)

Not an Unreasonable Amount
**Buffer Size Calculations**

- **Compare the Up, Down, Center Spread Buffers**

  \[ T_{\text{min}} = \frac{1}{F_c(1 + \Delta F)} \]

  \[ \Delta \text{bits} = \Delta F \cdot \Delta T \]

  \[ \Delta \text{Words} = \frac{\Delta F \cdot \Delta T}{40} \]

<table>
<thead>
<tr>
<th>Spread</th>
<th>Fc (GHz)</th>
<th>Tc min (ps)</th>
<th>Delta Tc (ps)</th>
<th>F SSC (Hz)</th>
<th># bits =dF*dT</th>
<th>#words</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>6.000</td>
<td>166.67</td>
<td>0.00</td>
<td>0</td>
<td>?</td>
<td>&gt;0</td>
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<td>30000</td>
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<td>6.23</td>
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</table>

- **Observations**
  - Bit interval spread is very small (0.83ps)
  - Buffer Sized is Basically Independent of SSC Choice and Reasonable in Size
SSC Support in the SAS-2 Fabric is a function of the SSC Option

- No SSC – no issue
- Center or Up spread SSC can be Supported in any Fabric Links
- Down Spread SSC on the Fabric Links Causes a Management Nightmare
Legacy Devices and SSC

- Legacy SAS does Not Support SSC
- SATA may or may not have SSC Enabled
- If SSC is supported on the uplink it will need to be Provisionally on a port-by-port basis because legacy SAS ports cannot have SSC active
- This Precludes Modulating the Reference Clock in a Multiplexing Device

SSC Range Required to Support 6G SAS and 6G SATA in 20xx?

- Up Spread 10,000 ppm Range
- Center Spread 7,500 ppm Range
- Down Spread 5,000 ppm Range
- No Spread 5,000 ppm Range (Rx Only)
<table>
<thead>
<tr>
<th>SSC Option</th>
<th>EMI Reduction</th>
<th>Legacy Support</th>
<th>Support Multiplexing</th>
<th>Buffer Size (DWords)</th>
<th>PHY SSC Range PPM</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Yes</td>
<td>&gt;0</td>
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<tr>
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<td>Yes</td>
<td>Yes</td>
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<tr>
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<td>No</td>
<td>No</td>
<td>7</td>
<td>5000</td>
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</table>

*Up and Center Spread SSC are the best solutions, Center Spread is Lower Risk*
Summary

- Recommend That We Support SSC
- Recommend Center Spread SSC of +/- 2500PPM
- Modify the Align Density Specification to Allow Higher Rates