Start-up Training Sequence Proposal

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Overview

- DFE receivers may require training before speed negotiation takes place.
- Applying a known pattern for training greatly improves time required for training.
- Ensure backwards compatibility.
- Use current protocol.
- Introduce training sequence only where needed.
- Leverage off existing spec based on DFE architecture.
OOB Sequence

Figure 116 — SAS to SATA OOB sequence

Time 0: OOB sequence begins
Time z: Speed negotiation sequence begins

X: Power on
SATA Speed Negotiation (Training not required)

Figure 115 — SATA speed negotiation sequence
SAS Speed Negotiation Window

If the phy's receiver device achieves dword synchronization at the speed negotiation window rate within SNLT, its transmitter device transmits ALIGN(1)s at the speed negotiation window rate for the remainder of the SNTT.

Phy's transmitter device transmits ALIGN(0)s at the speed negotiation window rate.

- Rate change delay time (RCDT)
- Speed negotiation window time
- Speed negotiation lock time (SNLT)

Figure 118 — SAS speed negotiation window
Table 66 — SAS speed negotiation sequence timing specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Time</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate change delay time (RCDT)</td>
<td>750 000 OOBI</td>
<td>The time the transmitter device shall transmit D.C. idle between rates during speed negotiation.</td>
</tr>
<tr>
<td>Speed negotiation transmit time (SNTT)</td>
<td>163 840 OOBI</td>
<td>The time during which ALIGN (0) or ALIGN (1) is transmitted at each physical link rate during the speed negotiation sequence. Derived from: OOBI x 4 096 x 40.</td>
</tr>
<tr>
<td>Speed negotiation lock time (SNLT)</td>
<td>153 600 OOBI</td>
<td>The maximum time during the speed negotiation window for a transmitter device to reply with ALIGN (1). Derived from: OOBI x 3 840 x 40.</td>
</tr>
<tr>
<td>Speed negotiation window time</td>
<td>913 840 OOBI</td>
<td>The duration of a speed negotiation window. Derived from: RCDT + SNTT.</td>
</tr>
</tbody>
</table>
SAS Speed Negotiation Sequence

Figure 119 — SAS speed negotiation sequence (phy A: G1, G2, G3, phy B: G2 only)
## New table for Speed Negotiation Window Rate G3

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Time</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed negotiation transmit time (SNTT)</td>
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</tr>
<tr>
<td>Speed negotiation window time</td>
<td>913 840 OObI</td>
<td>The duration of a speed negotiation window. Derived from: RCDT + SNTT.</td>
</tr>
<tr>
<td>Training sequence (TS)</td>
<td>750 000 OObI</td>
<td>Training sequence.</td>
</tr>
</tbody>
</table>
Training Sequence Only Used for G3 Speed Negotiation

If the phy's receiver device achieves dword synchronization at the speed negotiation window rate within SNLT, its transmitter device transmits ALIGN(1)s at the speed negotiation window rate for the remainder of the SNTT.

Phy's transmitter device transmits ALIGN(0)s at the speed negotiation window rate.

Training sequence (TS) for 250us
Training Sequence

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Purpose</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primitive sent twice</td>
<td>80 bits - Status or request</td>
<td>13.3ns</td>
</tr>
<tr>
<td>Scrambled data starting with seed 0h</td>
<td>800 bits - pseudo-random</td>
<td>133.3ns</td>
</tr>
</tbody>
</table>

D30.3 = 01111000111000011100b low frequency to provide an open eye.
Train$_p$: training receiver K28.5 D30.3 D30.3 D30.3

IncEmp$_p$: increase transmitter emphasis K28.5 D10.2 D30.3 D30.3

DecEmp$_p$: decrease transmitter emphasis K28.5 D30.3 D10.2 D30.3

TrainDone$_p$: training complete K28.5 D30.3 D30.3 D10.2

Done (Phy Adjust)$_p$: adjustment acknowledged K28.5 D30.0 D16.7 D01.4

NAK (Phy Adjust)$_p$: adjustment not acknowledged K28.5 D01.4 D31.4 D29.7

Amplitude adjustment?
Training Sequence Only Used for G3 Speed Negotiation

- Speed negotiation window rate G1
- Speed negotiation window rate G2
- Phy A: Speed negotiation window rate G3 Training sequence
- Phy B: Maximum speed negotiation window rate G3
- Final speed negotiation window - negotiated rate G3

- G1 support: phy A: yes phy B: no
- G2 support: phy A: yes phy B: yes
- G3 support: phy A: yes phy B: yes
- G4 support: phy A: no phy B: no

- ALIGN(0)s
- ALIGN(1)s
- Dwords transmitted by the link layer
- Long time
- Training sequence

Send TrainDone once trained
Final G3 Speed Negotiation Window Expanded

If TrainDone_p not received from both phys within 20ms then restart OOB.