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.
Figure 116 — SAS to SATA OOB sequence

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

Figure 118 — SAS speed negotiation window
Table 66 defines the timing specifications for the SAS speed negotiation sequence.

<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 OOB1</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 OOB1</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: OOB1 x 4 096 x 40.</td>
</tr>
<tr>
<td>Speed negotiation lock time (SNLT)</td>
<td>153 600 OOB1</td>
<td>The maximum time during the speed negotiation window for a transmitter device to reply with ALIGN (1). Derived from: OOB1 x 3 840 x 40</td>
</tr>
<tr>
<td>Speed negotiation window time</td>
<td>913 840 OOB1</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</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</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>

Training sequence (TS) 750 000 OOBi Training sequence.
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

- Speed negotiation lock time (SNLT)

- Speed negotiation transmit time (SNTT)
## 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 = 0111100011 1000011100b low frequency to provide an open eye.

Train\(_r\): 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 D91.4
- 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

- Time Z
- Speed negotiation window rate G1
- Speed negotiation window rate G2
- Phy A: Speed negotiation window rate G3 Training sequence
- Speed negotiation window rate G4
- Final speed negotiation window - negotiated rate G3

- Phy A Tx
- Phy B Rx
- Phy A Rx
- Phy B Tx

- 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
- Training sequence
- Long time
Final G3 Speed Negotiation Window Expanded

If TrainDone_p not received from both phys within 20ms then restart OOB.
Change to SAS Phy State Machine

Normal state machine startup with new training sequence

SP8: SAS_Start

SP6: OOB_AwaitNo COMSAS

-Set Rate-

SP9: SAS_Rate NotSupported

SP10: SAS_AwaitALIGN

SP11: SAS_AwaitALIGN1

SP12: SAS_AwaitSNW

SP13: SAS_Pass

G1 and G2

Start SL_IR Receiver

G3

SP27: SAS2_Training Sequence

SP14: SAS_Fail