Start-up Training Sequence Proposal

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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 and modify where needed.

Introduce training sequence only where needed.

Leverage off existing spec based on DFE architecture.
Figure 116 — SAS to SATA OOB sequence
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)

Long time

Speed negotiation window time

Figure 118 — SAS speed negotiation window
### SAS Speed Negotiation Table

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 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 (SAS1)

Figure 119 — SAS speed negotiation sequence (phy A: G1, G2, G3, phy B: G2 only)
## Training Sequence

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Purpose</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primitive sent four times</td>
<td>160 bits - Status</td>
<td>26.6ns</td>
</tr>
<tr>
<td>Series of 00h bytes transmitted scrambled per the existing</td>
<td>1600 bits - pseudo-random content for a DFE to</td>
<td>266.7ns</td>
</tr>
<tr>
<td>scrambler and 8B/10B encoder</td>
<td>train.</td>
<td></td>
</tr>
</tbody>
</table>

\[D30.3 = 0111100011100001100b\] low frequency to provide an open eye.

Train\(_p\): training receiver K28.5 D30.3 D30.3 D30.3

TrainDone\(_p\): training complete K28.5 D30.3 D30.3 D10.2

The number of bit is the requirement.
The time is for reference based on 6Gb/s operation.

Either running disparity is allowed.
Training Sequence Only Used for G3 Speed Negotiation

- Phy A: Speed negotiation window rate G3
- Phy B: Maximum speed negotiation window rate G3
- Final speed negotiation window - negotiated rate G3
- Send TrainDone_p once trained
- Final window time out 20ms

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

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

Config Options at G1 rate
Final G3 Speed Negotiation Window Expanded

If a phy has not both transmitted and received TrainDone within 20 ms the OOB sequence restarts and the highest speed is not reported.

Note removal of final ALIGN(0) ALIGN(1) sequence at the end. TrainDone_p shall indicate Dword alignment and ready for communication.
Normal state machine startup with new training sequence

- **SP8: SAS_Start**
- **SP6: OOB_AwaitNoCOMSAS**
- **SP9: SAS_RateNotSupported**
- **SP14: SAS_Fail**
- **SP10: SAS_AwaitALIGN**
- **SP11: SAS_AwaitALIGN1**
- **SP12: SAS_AwaitSNW**
- **SP13: SAS_Pass**
- **SP27: SAS2_TrainingSequence**

**Connections:**
- G1 and G2
- G3