

The meeting opened at 9:00 am with the approval of agenda and introduction of participants.

#### Attendance

Mr. Lawrence J. Lamers	Adaptec, Inc.
Mr. Ziad Matni	Agere Systems
Mr. Paul von Stamwitz	AMCC
Mr. Michael Wingard	Amphenol Interconnect
Mr. James A. Lott, Jr.	Dallas Semiconductor
Mr. Kevin Marks	Dell, Inc.
Mr. Ramez Rizk	Emulex
Mr. Douglas Wagner	FCI
Mr. Elwood Parsons	Foxconn Electronics
Mr. Mike Fitzpatrick	Fujitsu
Mr. Nathan Hastad	General Dynamics
Mr. Rob Elliott	Hewlett Packard Co.
Dr. William Ham	Hewlett Packard Co.
Mr. Barry Olawsky	Hewlett Packard Co.
Mr. Dan Colegrove	Hitachi Global Storage Tech.
Mr. George O. Penokie	IBM Corp.
Mr. Harvey Newman	Infineon Technologies
Mr. Schelto van Doorn	Intel Corp
Dr. Mark Seidel	Intel Corp.
Mr. David Uddenberg	LSI Logic
Mr. Brian Day	LSI Logic Corp.
Mr. Michael Jenkins	LSI Logic Corp.
Mr. Jason Stuhlsatz	LSI Logic, Engenio Storage
Mr. Edward Cady	Meritec
Mr. Galen Fromm	Molex Inc.
Mr. Michael Hopgood	Nvidia Corp.
Mr. Yuriy Greshishchev	PMC-Sierra
Mr. Tim Symons	PMC-Sierra
Ms. Cattalen Pelard	Quellan Inc
Mr. John Fobel	Ranco SysTech, Inc.
Mr. Alvin Cox	Seagate Technology
Mr. Stephen Finch	STMicroelectronics
Mr. Vit Novak	Sun Microsystems, Inc.
Mr. Kjartan Nesbakken Haugen	Tandberg Storage
Mr. Doug Loree	Toshiba
Ms. Ashlie Fan	TycoElectronics
Mr. Adrian Robinson	Vitesse Semiconductor
Mr. Gregory Tabor	Vitesse Semiconductor
Mr. Kevin Witt	Vitesse Semiconductor
Mr. Jeff Williams	Xiotech Corp.

40 People Present

#### 1. Review of documents and proposals

##### 1.1 Specification corrections

1.1.1 SAS-2 Correct receiver device jitter table DJ footnotes (06-169) [Elliott]  
<http://www.t10.org/ftp/t10/document.06/06-169r1.pdf>

Unanimously approved for recommendation to be included in SAS-2.

## 1.2 Modeling:

1.2.1 SAS-2 External link crosstalk budget suggestion and analyses (06-104) [Greshishchev and Molex]

<http://www.t10.org/ftp/t10/document.06/06-104r2.pdf>

Not reviewed this meeting.

1.2.2 Comparison of Equalization Schemes for 6Gbps SAS Channels (06-049) [Caroselli, Malipatil]

<http://www.t10.org/ftp/t10/document.06/06-049r1.pdf>

Not reviewed this meeting.

1.2.3 What a 6G-capable Serdes Adds to 3G Link Performance (06-132) [Jenkins]

<http://www.t10.org/ftp/t10/document.06/06-132r0.pdf>

Not reviewed this meeting.

1.2.4 SAS-2 Data Eyes vs De-Emphasis (06-206) [Witt & Robinson]

<http://www.t10.org/ftp/t10/document.06/06-206r2.pdf>

Half meter is typically the shortest cable and anything less is an unusual corner case. Should we specify a minimum cable loss? Crosstalk is not considered in this model or testing. Crosstalk will affect rise time and a lesser affect on jitter.

Vitesse recommendations:

- Do not define "optional" primitives for adaptive De-Emphasis in the Training Sequence unless technical need determined.
- Do Specify a Fixed 6dB Fixed De-Emphasis for External Links. Where does the tolerance go? Might be 6 - 7 dB to optimize for the .5 to 10 meter range to help the 10-meter end.
- Do Provide Adjustable De-Emphasis for Internal Links.
- Do Assume a Maximum of 6dB De-Emphasis for Link Analysis and Specification.
- Determine a Compliance Test Methodology for External Links. Compliance testing is a problem that has not been resolved.

Group consensus: When developing the budget for 6Gbps SAS external multilane cable applications, a non-adaptive de-emphasis at the transmitter device compliance point (connector) is assumed to avoid the need for a protocol to adapt de-emphasis. The testing and specification methodology to verify compliance needs to be developed. The verification method should result in a fixed amount of transmitter device de-emphasis at the connector of 6 to 7 dB.

The specification wording should not disallow the use of an adaptive transmitter de-emphasis scheme, but adaptive de-emphasis will not be assumed in the general application model.

## 1.3 Spread spectrum clocking:

1.3.1 SAS-2 SSC Investigation (06-064) [Olawsky]

<http://www.t10.org/ftp/t10/document.06/06-064r2.pdf>

Rev 2 additions were reviewed. FCC testing is defined better in the new material. Measurements showed more improvement is realized as transmitter frequency goes higher. Concern about random jitter introduced to clock when SSC is on was mentioned. Discussed backwards compatibility issues and the impact it has on the clock design. SSC is optional in SATA. How does the optional aspect affect FCC certification?

1.3.2 SAS-2 Spread Spectrum Clocking consideration list (06-129) [Cox]

<http://www.t10.org/ftp/t10/document.06/06-129r1.pdf>

Not reviewed this meeting.

### 1.3.3 Spread Spectrum Clocking Considerations (06-192) [Newman]

<http://www.t10.org/ftp/t10/document.06/06-192r0.pdf>

Shows block diagram of how SATA has implemented SSC and also how an Intel chip set has implemented SSC in the common clock at power up. All versions reviewed use downspreading. A diagram is included that shows the pipeline issue if two 3 Gbps SAS devices without SSC are feeding a 6 Gbps link with SSC. The protocol for 3Gbps does not include enough align primitives to avoid buffering issues with aggregation or rate matching.. SAS only has 2 aligns per 4096 dwords and SATA has 2 aligns per 256 dwords.

### 1.3.4 Symmetrical SSC in SAS-2 physical interface (06-193) [Greshishchev]

<http://www.t10.org/ftp/t10/document.06/06-193r0.pdf>

Yuriy discussed implementation issues with downspreading and advantages of centerspreading versus downspreading. There are also buffer overflow issues associated with the upspreading portion if centerspreading is used and the upspreading continues for 38uS.

### 1.3.5 SSC methodology and development

To focus the effort on SSC implementation, Alvin made the following proposition for the PHY working group to vote on based on SATA implementation and SATA's plan to keep the existing methodology for SSC:

If SAS implements spread spectrum clocking, the characteristics of downspreading (0 to -5000ppm maximum deviation) and frequency (30kHz-33kHz) shall be used.

Vote results: 15Y, 1N, 6A

This vote does not commit to including SSC as part of SAS-2 6Gbps, but was conducted so that time can be spent on other details as the incorporation of SSC. It is extremely difficult to include with the current non-SSC requirements already on place and the feasibility has been questioned.

When asked if there was an alternative to SC, no real solution was mentioned. A common mode specification may help, but data scrambling is already used, so there appears to be very few options.

## 1.4 Training sequence:

### 1.4.1 SAS-2 Start-up training sequence (05-397) [Newman]

<http://www.t10.org/ftp/t10/document.05/05-397r3.pdf>

Harvey made some significant changes to this proposal by removing the interactive transmitter device de-emphasis setting during the speed negotiation sequence. It was determined that the 609uS tuning window may not be sufficient and that this area in the sequence may just be used to verify 6G capabilities by having signal present rather than used for tuning. Alternatives were discussed which included initial receiver tuning to speed the process when the actual tuning begins or just sending a low frequency signal for use by a squelch detector. It was suggested that the train done primitive be replace by a burst of Align0's rather than create a new primitive. One new primitive will probably be requested as it provides a low-frequency pattern that should produce an open eye for initial tuning. This primitive should be repeated in the sequence at least a few times so that it can be recognized. A concern was voiced that this may restrict internal applications from the ability to optimize transmitter settings. This may be less of an issue for large OEM's, but a bigger concern for white box applications.

### 1.4.2 Proposal for Optional Adaptation of TX FFE Tap Weights (06-133) [Jenkins]

<http://www.t10.org/ftp/t10/document.06/06-133r0.pdf>

Not reviewed this meeting.

## 1.5 PHY specification format:

#### 1.5.1 SAS-2 TCTF and Minimum Transmitter Amplitude (06-234) [Olawsky]

<http://www.t10.org/ftp/t10/document.06/06-234r0.pdf>

The current TCTF allows a wide voltage level variance out of the transmitter (60% of budget). Need a real test load instead of zero length. The transmitter device could be characterized by a pair of TCTF's to produce a set of output requirements and the receiver device could be required to accept specified input. This would set requirements to derive a reference transmitter device and receiver device so that a simulation such as StatEye could be used to predict system performance based on channel characteristics. The current TCTF does not include return loss and crosstalk.

#### 4.4.2 Towards a SAS-2 Physical Layer Specification (06-011) [Witt]

<http://www.t10.org/ftp/t10/document.06/06-011r1.pdf>

Not reviewed this meeting.

#### 4.4.3 SAS-2 channels analyses and suggestion for physical link requirements (05-428)

[Greshishchev]

<http://www.t10.org/ftp/t10/document.05/05-428r0.pdf>

Not reviewed this meeting.

### 5. New Business

Galen Fromm will post a new S-parameter file for the mini 4x 10-meter cable that includes more test points than the original posting.

SAS-2 TCTF Candidate Touchstone File (06-245) [Fromm]

<http://www.t10.org/ftp/t10/document.06/06-245r0.s4p>

Alvin requested connector suppliers to provide test data for 6Gbps performance of the secondary port on SAS drive and backplane connectors.

### 6. Recommendations to Plenary

SAS-2 Correct receiver device jitter table DJ footnotes (06-169) [Elliott]

<http://www.t10.org/ftp/t10/document.06/06-169r1.pdf>

Unanimously approved for recommendation to be included in SAS-2.

### 7. Meeting Schedule

Bi-weekly conference calls starting June 1, 2006

#### PARTICIPANT INFORMATION:

All Participants should use the following information to reach the conference calls:

Toll Free Dial in Number: (866) 279-4742

International Access/Caller Paid Dial In Number: (309) 229-0118

PARTICIPANT CODE: 3243413

Webex information:

<https://seagate.webex.com/seagate>

Topic: SAS-2 PHY WG

Date: Bi-weekly starting Thursday, June 1, 2006

Time: 10:00 am, Central Daylight Time (GMT -05:00, Chicago)

Meeting number: 826 515 680

Meeting password: 6gbpsSAS

### 8. Adjournment

The meeting closed at 5:25 pm.