

1.0 The meeting opened at 9:00 am and participants introduced themselves.

2.0 Attendance:

Mr. Bernhard Laschinsky	Agere Systems
Mr. Rick Hernandez	Agilent Technologies
Ms. Pat Thaler	Agilent Technologies
Mr. Paul von Stamwitz	AMCC
Mr. Greg Vaupotic	Amphenol/Spectra-Strip
Mr. Stillman Gates	Broadcom
Mr. Ron Roberts	Broadcom Corp.
Mr. Dan Crain	Dell
Mr. Minchuan Wang	Dell
Mr. Kevin Marks	Dell, Inc.
Mr. Douglas Wagner	FCI
Mr. Elwood Parsons	Foxconn Electronics
Mr. Pak Chan	Hewlett Packard
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. James Rockrohr	IBM
Mr. George O. Penokie	IBM / Tivoli Systems
Mr. Schelto van Doorn	Intel Corp
Dr. Mark Seidel	Intel Corp.
Mr. Dennis Moore	KnowledgeTek, Inc.
Mr. Michael Jenkins	LSI Logic Corp.
Mr. David Geddes	Marvell Semiconductor, Inc.
Mr. Richard Uber	Maxtor Corp.
Mr. Edward Cady	Meritec
Mr. Galen Fromm	Molex Inc.
Mr. Jay Neer	Molex Inc.
Mr. Hock Seow	NEC Electronics America, Inc
Mr. Michael Hopgood	Nvidia Corp.
Mr. Yuriy Greshishchev	PMC-Sierra
Mr. Tim Symons	PMC-Sierra
Mr. Alvin Cox	Seagate Technology
Mr. Gerald Houlder	Seagate Technology
Mr. Robert Kando	Texas Instruments
Mr. Doug Loree	Toshiba
Ms. Ashlie Fan	TycoElectronics
Mr. Dan Gorenc	TycoElectronics
Mr. Kevin Witt	Vitesse Semiconductor
Mr. Michael Yeager	Vitesse Semiconductor
Mr. Jeff Williams	Xiotech Corp.

41 People Present

### 3.0 SAS PHY working group agenda:

#### 3.1 Review posted channel models

##### 3.1.1 Touchstone (s-parameter) file for TCTF ([05-355r1](#)) [Jenkins]

<http://www.t10.org/ftp/t10/document.05/05-355r0.pdf>

<http://www.t10.org/ftp/t10/document.05/05-355r0.zip>

##### 3.1.2 [05-384r0](#) SAS-2 Channel Models (3-Connector, Board-to-Board) Barry Olawsky

<http://www.t10.org/ftp/t10/document.05/05-384r0.pdf>

<http://www.t10.org/ftp/t10/document.05/05-384r0.zip>

##### 3.1.3 [05-389r0](#) SAS-2 Channel Models (4-Connector, Board-to-Board) Barry Olawsky

<http://www.t10.org/ftp/t10/document.05/05-389r0.pdf>

<http://www.t10.org/ftp/t10/document.05/05-389r0.zip>

##### 3.1.4 [05-390r0](#) SAS-2 Channel Models (3-Connector, Board/Cable/Backplane/Drive) Barry Olawsky

<http://www.t10.org/ftp/t10/document.05/05-390r0.pdf>

<http://www.t10.org/ftp/t10/document.05/05-390r0.zip>

##### 3.1.5 SAS-2 Multilane Cable Assembly Models ([05-398r1](#)) [Fromm]

<http://www.t10.org/ftp/t10/document.05/05-398r0.pdf>

##### 3.1.6 [05-401r0](#) SAS-2 Multilane Cable Assembly Model, one-half meter Galen Fromm

<http://www.t10.org/ftp/t10/document.05/05-401r0.pdf>

<http://www.t10.org/ftp/t10/document.05/05-401r0.zip>

##### 3.1.7 [05-402r0](#) SAS-2 Multilane Cable Assembly Model, one meter Galen Fromm

<http://www.t10.org/ftp/t10/document.05/05-402r0.pdf>

<http://www.t10.org/ftp/t10/document.05/05-402r0.zip>

##### 3.1.8 [05-403r0](#) SAS-2 Multilane Cable Assembly Model, three meter Galen Fromm

<http://www.t10.org/ftp/t10/document.05/05-403r0.pdf>

<http://www.t10.org/ftp/t10/document.05/05-403r0.zip>

##### 3.1.9 [05-404r0](#) SAS-2 Multilane Cable Assembly Model, six meter Galen Fromm

<http://www.t10.org/ftp/t10/document.05/05-404r0.pdf>

<http://www.t10.org/ftp/t10/document.05/05-404r0.zip>

##### 3.1.10 [05-393r0](#) SAS-2 Channel Model (4 boards / 3 mated connectors) Dan Crain and Kevin Marks

<http://www.t10.org/ftp/t10/document.05/05-393r0.pdf>

<http://www.t10.org/ftp/t10/document.05/05-393r0.zip>

##### 3.1.11 Bill Ham shared the FCAL S-parameter file format requirements (document under development): T11 05-764v0

Requires Matlab. Simulators introduce a separate set of variables. This document only addresses the file format. Greshishchev felt that the files provided were acceptable and will provide Ham with additional information regarding requirements. Details provided with files should include enough information for analysis, but should not be required to give away design features. Information such as measurement points, whether fixturing is de-embedded, etc, are the types of information needed to make accurate use of the files. Reference <http://www.t10.org/ftp/t10/document.05/05-357r0.pdf> for requirement set of the SAS measurements above. Magnitude angle (not log) and phase was listed as the preferred format for these files.

### 3.2 Review simulation results based on above models:

#### 3.2.1 PMC-Sierra SAS-2 channels analyses and suggestion for physical link requirements (05-428r0) [Greshishchev]

Assumption made with receiver having a 5 tap adaptable DFE. 5 taps may be more than required for SAS. Need to consider what the performance is for fewer taps.

Initial training can be done at OOB and then not repeated. Training with DFE designs is a continuous process and needs an initial starting point that training patterns can provide.

Suggestions for transmitter device and receiver device specification requirements are included in this document. They are based on the OIF CEI 6GLR specification that is apparently not used for any volume product today.

#### 3.2.2 Vitesse SAS-2 Channel Model Simulations (05-425r0) [Witt]

Vitesse used the approach of transmitter device de-emphasis rather than DFE for analysis. Showed improvement in eye opening but may not be enough in itself. Over-emphasis is also a concern. Results were similar to PMC analysis. Maybe a combination of transmitter device de-emphasis and receiver equalization should be considered to reduce the number of taps for the receiver equalization.

#### 3.2.3 SAS-2 Cable Reach Objective and Crosstalk (05-426r0) [Witt]

Robust 10m reach for SAS-2 is feasible with iPASS tm connectors, Tx de-emphasis, and Rx equalization.

### 3.3. Equalization

Is training required?

How is receiver equalization set?

Does transmitter de-emphasis also need to be set or controlled in some way?

Should a control method be devised so that these two interact to optimize performance?

Do the settings made for 6Gbps work for 3 and 1,5 Gbps signaling?

#### 3.3.1 05-397r0 SAS-2 Training sequence Harvey Newman

<http://www.t10.org/ftp/t10/document.05/05-397r0.pdf>

Not 8b/10b compatible. 8b/10b does not necessarily provide the right signals for training.

Not intended as total training, but enough of a start to provide adjustment to successfully accomplish speed negotiation.

No feedback from other end (closed loop).

What amount of time is necessary for adjustment convergence to get a good-enough error ratio to continue after “the red line”?

#### 3.3.2 SAS-2 Training Sequence Proposal (05-427r0) [Witt]

Don't need to know training patterns.

Need more time than the RCD to achieve equalization.

Is a new OOB sequence for longer speed negotiation windows for G3?

Would need to address more than just G3.

How long is needed for G4?

Should a closed loop approach be designed to also optimize the transmitter?

Question for IC producers: Is <500uS long enough for training 6G equalizer circuits to the point where data integrity is good enough for information to be transferred immediately following the end of the speed negotiation sequence?

### 3.4 Spread spectrum clocking discussion

Possibility of backwards compatibility issue with existing SAS target devices.

Illegal for SAS to transmit with current specification.

Reduces margin.

SATA: optional on transmitter, receiver must tolerate.

SAS: Receiver must tolerate if designed to attach to SATA devices, shall not transmit.

SAS multiple aligns provided significant help with frequency peaking.

Issue is with expanders and initiators running several PHY's on a common clock?

What is the benefit to justify including SSC?

Concern that clock recovery circuit at 6Gbps may not allow SSC.

- Identify problem areas. Internal multilane cables, expanders, initiators...
- Perform tests to determine benefit with SATA hardware at 3Gbps
- Will it work at 6Gbps?

### 3.5 PHY specification format:

Elliott: comparison of different existing specifications.

Interoperability points are at connectors.

Alpha points may cause more issues than benefit.

Concerns over transmitter near end specification.

Where does the equalization belong and should it be specified in a particular location?

Items for additional consideration:

#### 3.5.1 Should a compliant channel specification as in CEI be included?

How complicated are reference transmitter and reference receiver? (How many taps, etc.)

Can the channel be limited to between separable connectors?

Currently using the TCTF at connectors.

#### 3.5.2 Transmitter device specification:

1200 mV pk-pk max including pre-emphasis?

Minimum transmit voltage (800 mV minimum used in PMC- Sierra simulations)

Rise and fall time requirements

Return loss

Jitter

Pre-emphasis specification?

#### 3.5.3 Receiver device specification:

Input voltage

Return loss

Jitter tolerance

Noise floor or SNR?

4.0 No recommendations to plenary.

5.0 Meeting was adjourned at 6:20 pm.

6.0 Meeting schedule:

Kevin Witt will provide a posting for the development of the 6Gbps PHY specification. It will be posted prior to December 1 for discussion during two conference calls in December as indicated below:

Teleconference December 1, 2005 and December 15, 2005 concerning PHY specification for transmitter device and receiver device 10:00 am Central Time:

**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

url: [seagate.webex.com](http://seagate.webex.com) (no www)

Topic: SAS 6Gbps PHY

Date: Thursday, December 1, 2005 and December 15, 2005

Time: 10:00 am, Central Standard Time (GMT -06:00, Chicago)

Meeting number: 823 657 596

Meeting password: 6gigabit

Next face-to-face:

January 10, 2006 9:00am – 7:00pm

Embassy Suites Hotel Poenix