SCSI signal modeling study group (SSM) 01-020r0
December 13, 14 2000
Nashua, NH

Subject: Draft minutes for the SSM working group on December 13, 14, 2000 in Nashua, NH

This was the next meeting to address the general subject of modeling for parallel SCSI. Paul Aloisi of TI led the meeting. Bill Ham of Compaq took these minutes. There was a good attendance from a broad spectrum of the industry. Zane Daggett of Hitachi hosted the meeting.

Last approved minutes: 00-380r1.

1. AGENDA SSM MEETING

2. Introductions

Paul Aloisi opened the meeting and conducted the introductions and reviewed the meeting purpose. He thanked Zane Daggett of Hitachi Cable for hosting the meeting.

3. Attendance

Attendance at working group meetings does not count toward attendance requirements for T10 plenaries.

The following folks were present:

Name	Company	E-Mail/Phone
Paul Aloisi	TI	Paul_Aloisi@TI.com / 603 329-8687
Larry Barnes	LSI	larry.barnes@lsil.com / 719 533-7431
Umesh Chandra	Seagate	umesh_chandra@notes.seagate.com / 831-439-7264
Jason Chou	Foxconn	JasonC@foxconn.com / 408-919-6141
Zane Daggett	Hitachi	zdaggett@hcm.hitachi.com / 603-669-4347x236
Jie Fan	C&M	jfan@cmcorporation.com / 860-779-4864
Bob Gannon	JPM	rgannnon@jmpco.com / 860-537-6800
Chuck Grant	Madison Cable	cgrant@madisoncable.com / 508-752-2884x725
Bill Ham	Compaq	bill_ham@ix.netcom.com / 978 828-9102
Nicholaos Limberopoulos	C&M	nlimberopoulas@cmcorporation.com / 860-779-4815
Richard McMillan	Adaptec	Richard_mcmillan@corp.adaptec.com 408-957-6025
Martin Ogbuokiri	Molex	mogbuokiri@molex.com / 630-527-4370
Ken Plourde	Tempflex	kpourde@tempflex.com / 508-839-5987x232
Richard Uber	Quantum	richard.uber@quantum.com / 508-770-2568

Greg Vaupotic	Amphenol Spectra-Strip	greg.vaupotic@snet.net / 203-287-7425

4. Agenda development

The agenda shown was that used.

5. Approval of previous minutes

The minutes of the last meeting were reviewed and minor changes were made. Bill Ham moved and Paul Aloisi seconded that the draft minutes be approved. Motion passed unanimously. This document will be posted as document 00-380r1.

6. Action item review

The action items were reviewed with the status indicated in the action item section of the minutes.

7. Administrative structure

The present administrative structure for SSM is:

Paul Aloisi, TI, chair
Larry Barnes, LSI Logic, Vice chair
Bill Ham, Compaq, Secy

8. Presentation Policy

This item is included for easy reference and will be retained in future minutes.

It is the policy of the SSM working group that all material presented at the SSM working group shall be made available electronically and posted on the T10 web site.

Material presented at the meeting should be uploaded to the T10 web site two weeks prior to the meeting. Alternatively the material may be electronically supplied to the chair or secretary at the meeting where the material is presented at the discretion of the chair.

Material should be free from any statement of confidentiality or restriction of use and should not contain any pricing or product scheduling information.

9. Presentations

9.1 Cable extraction data, Chuck Grant, Umesh, Madison, Seagate cable media round robin 2

Deferred to next meeting.

9.2 Cable assembly modeling (transition region) - Bob Gannon, JPM

As part of the initial attempt to construct a transition region approach between round cable and a circuit board that is part of the connector. The particular case attempted did not appear to be a real SCSI construction but the modeling approach was still valuable. A parameter extraction from a physical description scheme using the Ansoft tool was attempted.

A twinax media construction was assumed for simplicity. A number of significant issues were identified and some advice for proceeding was delivered. This is a very difficult problem to approach from a physical description partly due to lack of precision in the physical properties in the transition region.

It was noted that perhaps a more fruitful approach to the complex transition regions issues would be parameter extraction from performance data (e.g. TDA).

9.3 Periodic Structures in transmission lines, Larry Barnes, LSI Logic

[Item is still active but no new input this meeting.]

9.4 IBIS precomp issue, Larry Barnes, LSI Logic

Larry led the discussion aimed at creating the BIRD (Buffer issue resolution document) for the IBIS committee. The following is the text of the proposal. This proposal is a significant change for the IBIS methodology and it is expected that it may require significant work to get this developed and accepted.

Larry created a framework for the actual proposal to the IBIS committee. This proposal will be an entirely new “keyword”. The details of this specification proposal will be presented to the IBIS committee.

9.5 Cable media modeling, Greg Vaupotic, Spectra Srip

Greg went through material supplied to Larry Barnes for the document relating to modeling non-uniform cable media. A copy of this material is included below. Greg also went thru a presentation relating to how to read the outputs from the Ansoft tool. Greg is actioned to post the document relating to reading the Ansoft matrix.

Modeling Cable

A Twist N’ Flat® ribbon cable is modeled as an example. Measurements from real samples are compared to modeled impedance. Regrettably, actual permittivity and dimensions are withheld due to proprietary concerns.

When a person lacks experience using electromagnetic simulators, and first starts modeling cable, careful attention must be given to several points.

Do not trust permittivity and loss tangent values provided on raw material data sheets. It is strongly recommended that material samples be measured using a wide bandwidth material analyzer, recording permittivity and loss tangent versus frequency.

Beginners usually want to start by examining real problems. This may not be the best way to begin. Instead, it might be better to gain modest experience by examining several structures where the results are already known. After the beginner can successfully model these known structures, achieving proper results, then careful examination of unconventional structures may begin. The Microwave Engineer’s Handbook Volume 1 (Artech House) provides many structures and has generalized graphs showing both even-mode and odd-mode impedance. If one uses the Handbook examples, consider setting permittivity equal to one. When permittivity equals one, signal velocity is 100% of light speed. Then the beginner may calculate capacitance from the Handbook to compare with simulated capacitance.

For light speed: propagation time per meter = 3.3356 ns / meter and we know that

$$\text{PropTime per meter} = Z * C$$

so we can say

$$3.3356 * 10^{-9} = Z * C$$

and we can therefore calculate the implied Handbook capacitance

$$C = \frac{3.3356 * 10^{-9}}{Z} \quad \text{pF / meter}$$

to compare with simulated capacitance.

Another area for concern is how a cable structure is drawn for simulation. Simulators have a boundary that is drawn around the cable image. The simulator defines this boundary as ground. This ground must be much larger that the cable image for the simulated results to be correct, especially if the cable in question is not shielded. The author will usually start with a boundary that is 10 times the size of an unshielded cable image. Experiment is recommended. If changing the boundary size has trivial effect on the simulated results, then the boundary is probably large enough.

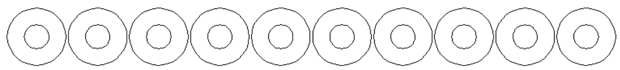
Sometimes, when drawing the cable, one might consider minor simplification to the drawing. The author’s simulator (Ansoft) has a very primitive drawing program that makes it very difficult to draw very fine detail. For example, it is much easier to draw a Twist N’ Flat® cable if the very thin lamination is ignored. The error will be very small, and the drawing will be much easier. Some structures, such as shielded parallel pairs, are easy to draw in detail.

One last point must be mentioned. With proper problem setup, the author has found all odd mode simulations to be correct. Even mode capacitance is also always correct. Even mode inductance is correct if simulations are performed using the L matrix and C matrix (no frequency dependence). However, when using the frequency dependant Impedance Matrix and Capacitance Matrix, serious errors have been observed in the calculated even mode inductance. Extreme caution is advised when calculating even mode inductance (and therefore even mode impedance and even mode propagation velocity). The source of this error is presently unknown.

An example

Five pairs from the flat region of a Twist N' Flat cable (very thin laminate ignored):

Undriven wires floating, not grouped.

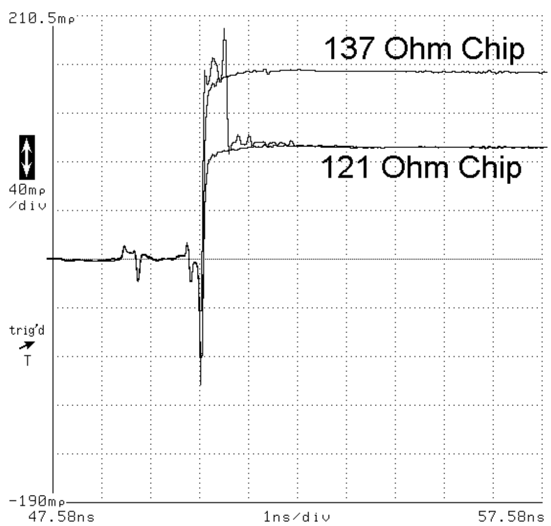


Ansoft was used calculate the L matrix and C matrix. Ansoft's output included the Characteristic Impedance Matrix from which odd mode Z was calculated.

(We know that $Z_{DIFFERENTIAL} = 2 * Z_{ODD}$).

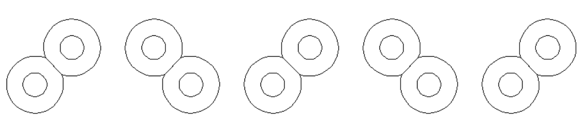
Results for Flat Region

Zodd = 71.89 Ω Þ Zdiff = 143.8 Ω



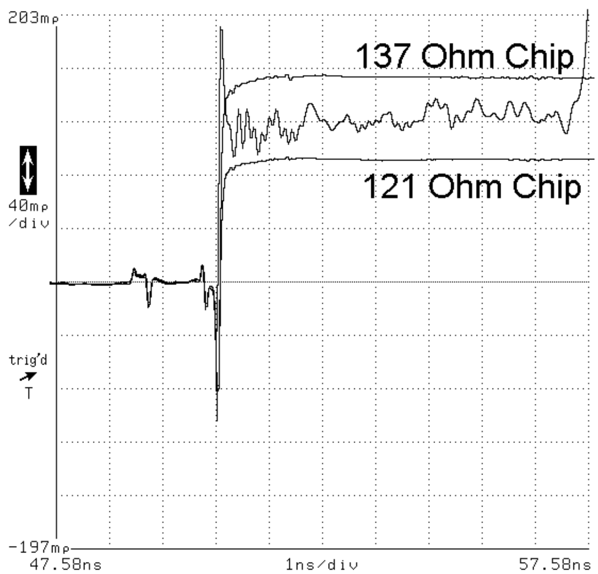
Expect 144 Ω from Modeling, measure ≈ 142 Ω

Twist Section



Results for Twist Region

Zodd = 62.77 Ω ⇒ Zdiff = 125.5 Ω



Expect 125.5 Ω from Modeling, measure ≈ 126 Ω

10. Matrix development for SSM

The following summarizes the present position for the SSM matrix. This matrix is a concise description of the methodology to be used for the respective areas of the point to point SCSI bus segment. Several of the areas were significantly modified at this meeting. Note that the multidrop areas have not yet been identified.

This section contains some repeated information from the last minutes as it continues to be relevant and current.

10.1 Transceiver chips: owner, Dean Wallace (need new owner)

Interface is at packaging pins
Model types: Behavioral only (because it is the only transportable type)
Data patterns: TBD

ISI compensation: required but not presently believed compatible with IBIS capability – this means that IBIS will have to be enhanced.
Single line required - cross talk from non SCSI sources not considered in the model, SCSI line cross talk is not significant within the transceiver. Therefore multiline models are not required for transceivers. (Possible risk with some package types.)

10.2 Bus segment termination: owner, Paul Aloisi / Don Getty

No new content information.

Interface is at package pins
Model types: Either circuit or behavioral
Terminator type: multimode
Single line only

10.3 Host bus adapter / target board (transceiver board): owners, Lee Hearn / Matt Schumacher

Interface is at transceiver board connectors used for the SCSI link (at the board side of the connector - not including the connector), transceiver chip pins, terminator chip pins, unused connectors are part of the board
Model types: Circuit
PCB construction: edge, broadside, dielectric type / thickness, vias, pads, discontinuities
Single line, multiline

10.4 Mated connectors: owner, Martin Ogbuokiri

No new content information.

Interface is at transceiver board and the beginning of the cable assembly transition region
Model types: Circuit
Connector types: VHDCI, SCA-2, HD68
Mounting style: thru hole, SMT,
single line, multiline

Connector models are in place at the Molex web site and pointers are now in place on the T10 site.

10.5 Transition regions: owners, Bob Gannon, Greg Vaupotic

Interfaces are at the connector termination and the uniform media

Model types: circuit
Construction types: twisted flat, round fanout, laminated round, IDC flat?
Single line multi-line

A start was made in this area – see Bob Gannon presentation above.

10.6 Uniform cable media: owner, Jie Fan, Zane Daggett, Greg Vaupotic

Interfaces are at the beginning of the cable assembly transition region on either end.
Model types: circuit
Cable types: flat, round shielded, round unshielded twisted flat?
Single line, multiline

10.7 Backplane: owner, Larry Barnes

Interfaces: connectors mounted on the backplane, directly mounted components, (this subject is still not settled)
Model types: circuit
PCB construction: edge, broadside, dielectric type / thickness, vias, pads, discontinuities
Single line, multiline

Issue: how to handle the unmated connectors on the backplane. Two sub issues: (1)lack of existence of unmated connector models and (2) convergence of the simulation with dangling open circuits. The latter can be handled by adding a high value resistance to the open circuit to "fool" the simulator.

10.8 Cable assemblies, owner TBD

Interfaces: connectors
Model types: circuit (possible combination of circuit and behavioral)
Constructions: point to point, multidrop

10.9 How to develop IBIS model annex, Barnes

11. Simulation integration strategy

Determine the goal of the simulation (examples: validate the basic behavior of a new component in a system, troubleshooting guidance, qualification of the signal integrity in a specific configuration, characterization of the expected EMI performance)

Determine the specific characteristics that are sought (example: ??)

Define the topology

Define the collection of components

Obtain the models for all the components

…………subject discussion truncated – will continue next meeting.

11.1 System configurations - Topology

Not discussed but reaffirmed as needed for the document

11.2 Data patterns, Bill Ham (new owner)

The training pattern specified in SPI-4 shall be used as one input pattern. Clock-like patterns are also needed (full data rate, 1/32 of the data rate). Isolated “1’s” and “0’s” – stable period at least a round trip time before the isolated bit.

The following is extracted from SPI-4 as the only existing description of the training pattern. This description needs to be modified in a way that takes the protocol sequencing out but leave a description of the training pattern itself. It is clear that the simulation that uses the training pattern needs to be aware of the specific details of the application (such as, data phase speed and intensity of precompensation to be used).

[beginning of training pattern description]
10.8.4.2.3 DT DATA OUT phase training pattern
The target shall request a training pattern on a DT DATA OUT phase by:
1) negating the SEL signal a minimum of two system deskew delays before changing the MSG, C/D,and I/O signals, and
2) asserting the SEL signal a minimum of two system deskew delays after asserting the MSG signal and negating the C/D and I/O signals.
The target shall begin the training pattern no sooner than two system deskew delays after negating the SEL signal. The target shall transmit the following training pattern:
1) disable precompensation;
2) assert REQ and P_CRCA signals;
3) wait 32 transfer periods (e.g., 200 ns at fast-160);
4) negate REQ and P_CRCA signals;
5) wait 32 transfer periods (e.g., 200 ns at fast-160);
6) set precompensation to negotiated state;
7) negate SEL signal;

8) simultaneously assert and negate REQ and P_CRCA signals at the negotiated rate for 64 transfer periods, (e.g., 400 ns at fast-160); and
9) on detection of the 8th 0000010011111011b pat t ern on the DB(15- 0) signals the target shall begin asserting and negating REQ to indicate to the initiator valid data may be sent. The number of REQ transitions shall not exceed the negotiated offset.

The initiator shall begin the A section of the training pattern on detection of the assertion of the SEL signal with MSG true and C/D and I/O false. The initiator shall transmit the following training pattern:
Start of A section;
1) simultaneously assert ACK, P1, and DB(15-0) signals;
2) wait 32 transfer periods (e.g., 200 ns at fast-160);
3) simultaneously negate ACK, P1, and DB(15-0) signals;
4) wait 32 transfer periods;
5) simultaneously assert and negate ACK, P1, and DB(15-0) signals at the negotiated rate for 128
transfer periods, (e.g., 800 ns at fast-160);
Start of B section;
6) on the 128th transfer period negate P1, and DB(15-0) signals while continuing to assert and negate ACK at the negotiated rate for 8 transfer periods (e.g., 50 ns at fast-160);
7) negate ACK for 8 transfer periods;
8) simultaneously assert and negate P1 and DB(15-0) signals at twice the negotiated rate for while asserting and negating ACK at the negotiated rate for 48 transfer periods (i.e., simultaneously
repeat a 1100b bit pattern 12 times on each signal); and
Start of C section;
9) assert and negate ACK at the negotiated rate for 128 transfer periods while repeating a 0000010011111011b bit pattern eight times on P1 and DB(15-0).
At the completion of the training pattern the initiator continues asserting and negating the ACK signal at the negotiated rate (e.g., 6,25 ns transfer period at fast-160) and the P1 signal at twice the negotiated rate
(e.g., 12 ns transfer period at fast-160). When the initiator is ready to transfer data and there are outstanding REQs it shall reverse the phase of P1 (see 10.8.4.3).

[end of training pattern description]

[The following is retained from the last minutes until transferred into the SSM document]

A preliminary discussion of the issues involving data patterns was held. The following resulted:

Data patterns need to consider the following properties:

- Intersymbol interference effects on single lines
- Cross talk from other SCSI lines
- driver release effects (driven to hi Z)

- Residual jitter (clock like patterns)
- Word patterns as well as individual patterns
- SSO
- Worst case digital patterns
- Sinusoidal patterns
- Resonance sensitivity

A spirited discussion concerning how to deal with receivers that modify the input signal (either adaptively or not) was held. Is this part of the signal path or not?

A more general concept of data pattern is possible with simulation because the inputs can be selected in the model. For example, skew from line to line and skew within the same line can be introduced. This latter was not considered in any detail but promises to be a significant benefit of modeling.

11.3 Data rate, Dean Wallace (need new owner)

[Retained from the last minutes until transferred into the SSM document]

Data transfer rates in SCSI are determined by more than the highest frequency content of the signals. Specifically, single transition, double transition, width, specific protocol variant and adaptive filtering affect the data rate. Therefore one must be careful in simulation to ensure that the relationship between the analog signals and the application is understood.

The following table will be added to the document that shows some of the relationships:

SCSI variant	REQ/ACK maximum frequency (MHz)	Data line maximum frequency (MHz)	Minimum rise / fall time (ns) (20-80%)	Maximum launch amplitude
SCSI-1 SE	async - NA	NA	NA	5.25V
SCSI-2 SE	5 MHz	2.5 MHz	NA	5.25V
SPI-1 SE	10 MHz	5 MHz	5 ns	5.25v
Ultra SE	20 MHz	10 MHz	5 ns	3.7v
Ultra2 LVD	40 MHz	20 MHz	1 ns	2.2 V DFpp
Ultra 160 LVD	40 MHz	40 MHz	1 ns	2.2 V DFpp
Ultra 320 LVD	80 MHz	80 MHz	1 ns	2.2 V DFpp
Ultra 640 LVD	160 MHz	160 MHz	???	???

12. Tools:

Not discussed at this meeting

13. Document framework, Barnes

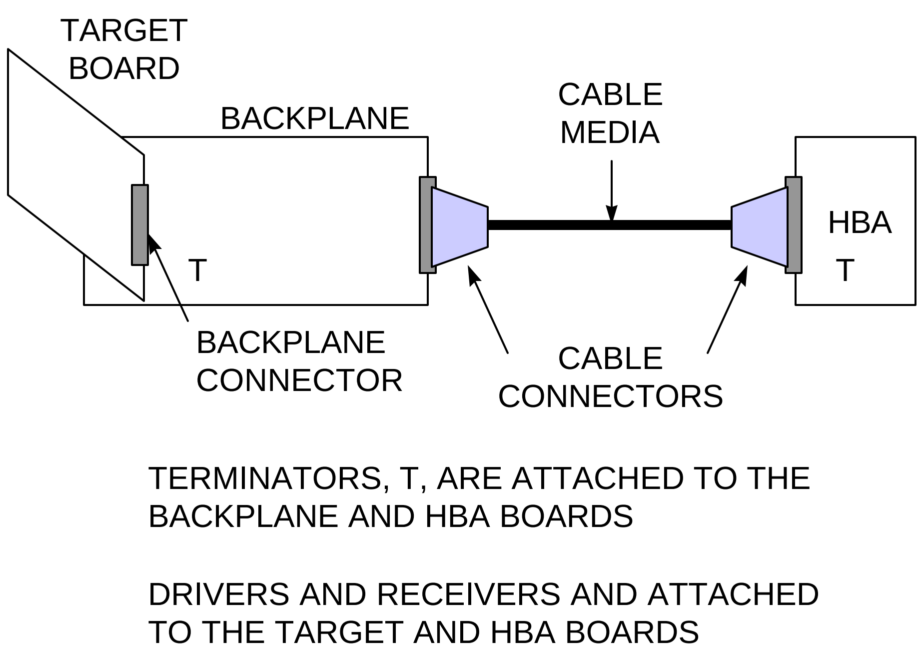
14. Should the group standardize on the IBIS connector matrices?

To be answered by the group in December.

15. New business

15.1 Creation of a trial simplified composite simulation

The group created a trial simplified composite simulation effort. The general configuration to be considered is shown below:



This is intended to be used as an example of a realistic complete SCSI segment and is expected to show where we have weaknesses in the concepts and model interfaces.

The general idea is for models of each element to be supplied in the form previously recommended and to actually create an overall integrated model that will yield waveforms.

Owners for each component were assigned as follows:

Backplane: Database, Molex; Parameter extraction from data base, LSI Logic (Larry Barnes)

Backplane connector, Molex

Terminators, TI (Paul Aloisi)

Target Board and driver, Seagate (Umesh Chandra)

HBA Board and driver, Adaptec (Richard McMillan) (Umesh backup)

Cable media, Amphenol Spectra Strip (Greg Vaupotic)

Cable connector, Molex

Overall integration of pieces, LSI Logic (Larry Barnes)

The owners are expected to have tangible models available before the next SSM meeting.

16. Next meetings

Scheduled meetings:

February 21-22, 2000 1:30PM to 6 PM 02/21 9AM to 6:00PM 02/22, Southern CA Foxconn

Requested meetings:

April 4-5, 2000 1:30PM to 6 PM 04/04 9AM to 6:00PM 02/05 Worcester, MA (Madison)

17. Action Items:

17.1 Action items from previous meetings

Status as of the December 13, 2000 meeting is shown.

Larry Barnes will hatch a BIRD at IBIS to incorporate transmitter ISI compensation as defined by SPI-4 (pre compensation).

Status: needs group input for resolution (expected today) -- carried over

Bruce Manildi to provide access information for the Seagate transceiver models to the T10 web site.
Status: A commitment now exists from the chip supplier to Seagate for IBIS models (no precomp). Encrypted HSPICE models are currently available from Seagate. T10 web site info still needed. - carried over with significant progress.

Richard McMillan to provide access information for the Adaptec transceiver models to the web site.
Status: Larry Lamers is no longer with Adaptec. The present status of this item will be determined by Richard. -- carried over

Chuck Grant, Madison Cable to provide access info for a cable media model to the T10 web site.
Status: model is done, verified and will be made available in circuit form - still needs info supplied to T10 web site - carried over

Bob Gannon to produce matrix of transition regions and issues with each.
Status: partially done

Zane Daggett, Hitachi, to provide cable media models to the SSM web site (per last meeting minutes).
Status: Clint is no longer with Hitachi, action assigned to Zane D temporarily - carried over

Paul A to send emails to all folks with open action items on Tuesday of each week (until the action item is completed).
Status: ongoing

Larry Barnes to take the material in the SPI-3 and SPI-4 document relating to the signal budget and figure out how to incorporate into the SSM document
Status: carried over

Larry B to send emails to all folks with open document issues on Tuesday of each week (until the issue is closed).
Status: ongoing

Section editors to provide material to Larry for the next revision of the document.
Status: ongoing - draft of guidelines for electromagnetic modeling of twist and flat media from Greg V.

Larry Barnes to bring a “bird” document template to be filled out in the December meeting
Status: done

Umesh to describe his experience with using HSPICE for an entire system simulation including validation.
Status: overcome by events

Bill Ham to add the interoperability material to his section
Status: partially done

17.2 New action items from present meeting

Greg Vaupotic to post the document relating to reading the Ansoft matrix.
Status: new

18. Adjourn

The meeting adjourned at 6:00 PM