Passive interconnect performance working group (PIP)      02-143r0
April 2, 2002
Nashua, NH

Subject: Draft minutes for the SCSI passive interconnect performance
working group, PIP, in Nashua NH on April 2, 2002

Zane Daggett, chair, led the meeting.  Bill Ham, secy, took these
minutes.  Hitachi (Zane Daggett) hosted the meeting.

Previous approved minutes: 02-082r1

## 1. Introduction

Zane Daggett, chair, opened the meeting, thanked the host, conducted the
introductions, and reviewed the meeting purpose.

## 2. Attendance

The following were present:

| Name | Organization | e-mail | Phone |
|------|-------------|--------|-------|
|      |             |        |       |

No attendance list is available for these minutes.

## 3. Agenda development

The agenda shown was that used.

## 4. Approval of previous minutes

Motion (Ham) that the draft minutes from the previous meeting be approved as modified.  Motion passed unanimously.

The methodology for minutes uses the draft/approved minutes scheme with posting to the t10 web site of the minutes as the vehicle for publication.  Postings are announced to the SCSI reflector after the posting is verified to be on the web site.

Minutes will be in .pdf format.

## 5. Review of action items

Action items were reviewed and the status is listed below in the action items section.

## 6. Administrative structure:

The present administrative structure is:

Chair:Zane Daggett, Hitachi
Vice Chair: Greg Vaupotic, Amphenol Spectra Strip
Secretary:  Bill Ham, Compaq

## 7. Review of industry activities

Bill Ham briefly reviewed the T10, T11, and SFF activities relating to testing and modeling.  He noted that the T11 modeling activity has had its eighth meeting and is in the process of producing its first draft document which has been posted on the T11 web site.  The next FCSM meeting is scheduled for T11 week in April 2001.

Bill noted the present activities relating to 3 gig and 4 gig speeds as the next stop for Fibre Channel disk drive interface.

The SFF SSWGS on high speed serial performance has adopted a duality policy where either time or frequency domain is acceptable.  This requires use of special conversion tools provided by atSpeed.  Test fixture effects are taken into account right at the interconnect boundary.  Agreement of better than 2% was demonstrated for 1 Gigabaud signals created by transforming TDT measurements into frequency domain and back again (convolving with the data pattern used) and direct measurement of eye diagrams.


## 8. Presentations on new topics


## 9. Presentations on old topics


### 9.1 Differential capacitance testing for PIP, Greg Vaupotic Spectra Strip

[new discussion in April led by Madison, Amphenol not present at this meeting]

Madison noted that they routinely use the methodology specified in SPI-4.  They also said that this was the "industry standard" method.  Therefore, the conclusions reached in February, where the time domain methodology would be adopted, may not be the whole story.

Motion Zane/Fan that the differential capacitance methodology specified in SPI-3/4 be adopted for PIP.  Other methodologies may be considered provided the other methodologies give equivalent results.

Motion passes without objection.

[discussion from the Feb 2001 meeting:]

Greg presented the case that the differential capacitance measurement as documented in SPI-3 and SPI-4 is not practiced.  He recommended that we remove this measurement methodology from the suite and substitute an extraction method.  Differential capacitance will be extracted from a calculation from differential impedance (square root of L/C) and differential propagation time (square root of LxC).  Sample lengths are to be determined and may vary with construction.

Greg is actioned to prepare a detailed proposal for the revised measurement process.


## 10. Round robins

A new document has been created to document the details of the round robin testing activities for PIP that have been substantially completed. All details for completed round robins will be contained in this new

document and will be removed from the active minutes.  At the moment the only round robin in this category is cable media round robin 1.  Please see the new document "PIP round robin testing" for information about cable media round robin 1.

The following motion made in a previous meeting is retained due to its important content for round robin testing.

**Motion Daggett/Martin O that samples used for round robins will be identified by the manufacturer of the samples in the active minutes unless the manufacturer specifically requests that his sample be identified in a way that does not indicate the manufacturer. It is understood that the final published results and details in the "PIP round robin testing" document will not contain any manufacturer identifications.**

Motion passes 11/0/1

## 10.1 Bulk cable round robin 1

This round robin is no longer active

[Data from this round robin has been transferred to 01-076.

## 10.2 Bulk cable round robin 2 (Expanded parameter set), Greg Vaupotic, Amphenol Spectra Strip

[Material in this section is retained in the minutes until such time as the report for this round robin is complete enough to transfer to 01-076.  Progress was made - see section on status]

Round robin 2 is based on a significantly more precise specification of the measurement details than round robin 1.

### OBJECTIVE

For several characteristics, determine simplest measurement method which compares favorably to the best method.  This is accomplished by measuring several samples using several methods, with results being compared later.  Most Round-Robin participants will not be able to use all methods; each will do what they can.

### DATA PRESENTATION
- Data presented in MS Excel spreadsheets, for later by compilation by coordinator.  Participants not able to present electronically are, of course, permitted to present data as recorded.
- Graphs/plots presented prior to final compilation shall be 1 to 1000 MHz, log frequency, even though impedance data is only collected down to 10 MHz. This facilitates comparing data sets for resonance effects.
- Report impedance as differential Ohms.  "Attenuation" shows gain as dB / meter.

- Report Propagation time Skew as measured (e.g.: 127 ps / 25 meter length) as table (Excel).

<u>**SAMPLES**</u>
All samples are 25 meter length.  Unshielded samples (twisted pair ribbons) are to be suspended from ceiling, with minimum of crossovers and keeping sample as spread out as possible (to minimize crosstalk effects).
**Sample 1**   Round twisted pair cable having overall shield, 28 AWG 7-36 TC  (Hitachi)
      Measure pairs 1 (Heat shrink 1), 7 (Heat shrink 2), and 34 (Heat shrink 3) (each pair to be secured with heat shrink tubing)
**Sample 2**   Round twisted pair cable having overall shield, 30 AWG solid TC  (Madison)
      Measure pairs 1 (Heat shrink 1), 7 (Heat shrink 2), and 34 (Heat shrink 3) (each pair to be secured with heat shrink tubing)
**Sample 3**   Twisted pair ribbon having no flats.  (Spectra-Strip)
      Measure pairs 1, 3, and 5 (wires 1-2, 5-6, and 9-10)
**Sample 4**   Twisted pair ribbon having flats at TDB inch intervals (Hitachi)
      Measure pairs 1, 3, and 5 (wires 1-2, 5-6, and 9-10)

All samples are 25 meter length.

<u>**ATTENUATION**</u>
Record S21 using log scale (really is gain).  Use 30 Hz IF BW.  Where possible, use 401 points.  Record from 1 to 1000 MHz, log sweep.  In addition to recording sweep, record actual values (using "markers") at 80, 160, and 200 MHz.

**Balun Methods**, using fixture described in 00-339r0 (balun with matching resistors).  For consistency, use matching network comprised of one 68 $\Omega$ shunt and two 47 $\Omega$ series resistors (1/8 W 5% carbon).

**Method A**  Calibrate by storing fixture response.  Then measure sample.  Then remove fixture response. ("normalized")

**Method B**  Full 2-port calibration.  Use 121 $\Omega$ ± 1% chip resistor (Panasonic EJR series) for "load", for "short" solder test points of fixture together, for "open" position matching   resistors as will be when measurement is made.  For "thru", attach both fixtures together.

**4-port Network Analyzer Methods:**
**Method C**  Full 4-port calibration.  Calibrate for 100 $\Omega$ environment.

**Method D**  Full 4-port calibration.  Calibrate for 122 $\Omega$ environment (software "corrects" for Z).

## DIFFERENTIAL IMPEDANCE
Use 30 Hz IF BW.  Where possible, use 401 points.  Record from 10 to 1000 MHz, log sweep.

### Hybrid Junction Method
**Method E**  See Appendix 1 for outline regarding fixture and calibration.

### 4-port Network Analyzer Method
**Method F**  Full calibration of one differential port.  Calibrate for 100 $\Omega$ environment.

## SKEW PAIR to PAIR
Per SPI-3 TDR method. Please record propagation time of each leg of each pair. Pair propagation time is the average of these two readings. Doing this allows us to examine within pair skew.

| Pair # | Propagation time + signal | Propagation time – signal | Pair propagation time Average (+,–Sig) |
|---|---|---|---|
| 1 (or shrink 1) | | | |
| 3 (or shrink 2) | | | |
| 5 (or shrink 3) | | | |

## LOGISTICS
Companies providing a sample will send to first name on below list. Round cable sample shall be on spools.  Flat cable sample shall be on pads.

The first person on the list will send samples to second person.  The second to the third, and so forth.

| Company | Person | Address | |
|---|---|---|---|
| Amphenol Spectra-Strip | Greg Vaupotic (203) 287-8725 | 720 Sherman Ave Hamden  CT  06410 | greg.vaupotic@snet.net |
| Hitachi Cable | Zane Daggett (603) 669-4347 | 900 Holt Avenue Manchester  NH  03109 | zdaggett@hcm.hitachi.com |
| Madison Cable | Jie Fan (508) 752-2884 | 125 Goddard Memorial Dr. Worcester  MA  01603 | jie.fan@madisoncable.com |
| Seagate | Umesh Chandra (831) 439-7264 | 4585 Scotts Valley Drive Scotts Valley  CA 95066 | Umesh_chandra@seagate.com |
| Madison Cable (retest) | Jie Fan (508) 752-2884 | 125 Goddard Memorial Dr. Worcester  MA  01603 | jie.fan@madisoncable.com |
| Hitachi Cable (retest) | Zane Daggett (603) 669-4347 | 900 Holt Avenue Manchester  NH  03109 | zdaggett@hcm.hitachi.com |
| | | | |
| END  Amphenol Spectra-Strip | Greg Vaupotic (203) 287- | 720 Sherman Ave Hamden  CT  06410 | greg.vaupotic@snet.net |

| | 8725 | | |
|---|---|---|---|

## TEST METHOD CAPABILITIES
Table below shows anticipated test capabilities of participants.

| Company | Balun A | Balun B | 4-port C | 4-port D | Hybrid E | "4-port" F |
|---|---|---|---|---|---|---|
| Amphenol | yes | yes | maybe | maybe | yes | maybe |
| Hitachi Cable | yes | yes | no | no | yes | no |
| Madison Cable | no | no | yes | yes | no | yes |
| Seagate | yes | yes | no | no | yes | no |
| Adaptec | tbd | tbd | yes | yes | tbd | tbd |

## APPENDIX 1
### Hybrid Junction Test Fixture

The hybrid junction converts an unbalanced 50 Ω input into two balanced 50 Ω outputs (two signals having 180° phase, 100 Ω differential).   The selected hybrid junction is the M/A-COM
H-183-4.  This is specified from 30 MHz to 3 GHz.   However, it may be used from 10 MHz to 3 GHz when used with a careful calibration.

50 OHM TERMINATION

B    180° PHASE    D

M/A-COM

H-183-4

A    0° PHASE    C

COAX TO NETWORK ANALYZER

6 dB ATTENUATOR 3 PLACES

FIXTURE MADE WITH SHORT PIECES OF .141 SEMI-RIGID COAX SOLDERED AT ENDS

ABOUT 3 INCHES
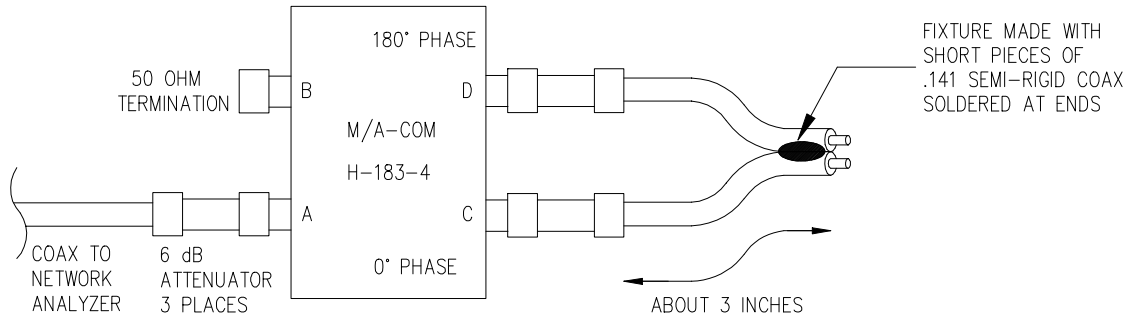
### OUTLINE for Calibration Procedure

Attach fixture to analyzer port 1.  Semi-rigid coax strongly recommended.
Preset Network Analyzer to default condition.  Then set analyzer to:
Power = 10 dBm    Points = 401    Linear Sweep (??)    Start = 10 MHz
Stop = 1 GHz
30 Hz IF BW

With attenuators attached, BUT with semi-rigid fixture removed, calibrate port 1.  This is accomplished using precision standards attached to the two attenuators on the right.
Two sets of standards are required.

When finished calibrating port 1, attach semi-rigid coax fixture (which, having no sample attached, is an "open" circuit)

- Set analyzer to look at S11 Phase.  Set phase scale to 10° per division.
- Enable port extensions
- Adjust port-1 extension for 0° across the frequency range (expected for an open circuit).  This compensates for the fixture's propagation propagation time.  Above 800 MHz, it will not be possible to achieve exactly 0°.  This is because the fixture is not a perfect open circuit.  The attachment stubs cause small undesired parasitics.  (Port extension for above fixture is about 380 ps.)
- Set the analyzer to look at S11   Set Z Reflected = On   Set scale = Linear

Important – The analyzer has been calibrated to 50 Ω.  The actual impedance at the calibration plane was, in fact, 100 Ω differential.
Multiply measurements by two for differential impedance.

### Measurement using Open/Short Method

Two measurements are required for each pair that is examined.  First, record the impedance of the pair with the far-end "open".  Then record

again with the far end "shorted".  The impedance is then calculated with
the following equation:

$$Z = \sqrt{(Z_{OPEN})(Z_{SHORT})} \quad \text{This is the value to}$$

report.

**10.2.1 Status of bulk cable round robin 2**

[April 2002 status:]

Samples are at Seagate awaiting transfer to Amphenol.  Zane questioned
whether this round robin should be continued due to lack of progress.

Madison suggested that the contributions from the long sample prep area
are causing significant errors in the measurements.

Jie agreed to provide a draft of the round bulk cable section by the
editing meeting on April 19, 2002.

[Greg V. presentation in February 2002:]

Greg presented data from three different companies at the February
meeting.  There was general agreement between Spectra Strip and Seagate
on the S21 data for round cable while the Madison data diverged
significantly from the other two for twist and flat bulk cable.

One major difference was that Madison used a 4 port network analyzer (no
baluns) while Spectra strip and Seagate used a 2 port with a balun.
There was no agreement on whether the 4 port or the 2 port was more
accurate.

Seagate's first data showed significant structure above approx 500 MHz
which may be due to the details of how the balun fixture was built.

The possibility of additional resonant conditions caused by the details
of the measurement was raised.

For twist and flat samples there was serious disagreement between the 2
port with baluns and the 4 port with no baluns.  The 4 port measurements
made the samples appear much better.  Other details of the measurement
process were also identified.  Some additional experimentation is
expected to be done by Amphenol Spectra Strip before the next meeting.

In any case there are critical details that must be tied down before we
have any confidence in high frequency measurements or on non-uniform
constructions.

[End of status update for February]

Madison (retest) now has the samples and will forward to Hitachi
(retest) in the sequence shown in the chart.

[Status for October 2001:]

Seagate has corrected the measurement process and has forwarded to Greg V. Greg is preparing a summary of results. Agreement is vastly improved with this correction (to within less than 1dB).


[Status at August 2001 meeting:]

Seagate presented an update in the form of 01-256r0.

Differences in the data presentation between the Seagate and the Amphenol of approximately 20 dB were noted. It was determined that this difference is probably due to the attenuation of the test fixture being included in the data presented by Seagate.

This is yet another example of the critical importance of following the details of the instructions for executing both the measurement process and the data presentation process if one desires to have agreement.


Greg foresees a follow-on round robin with a more complete suite of tests and draft procedures including both those used in round robin 2 and other tests not included in round robin 2 but viewed as useful.


## 10.3 Backplane round robin 1, Umesh Chandra, Seagate


[New info in February]

Present status: LSI, Seagate, and Maxtor has completed the first round and the boards will be passed to JPM. Seagate has significantly progressed on the results report.


[Below this point material is retained until round robin is completed.]

This effort is needed to add backplane testing methodology to the test suite. The basic idea is to acquire some small selection of SCSI backplanes and send these around for testing at different companies.

Umesh is actioned to select 2 boards for use in the round robin.

Umesh has documented the procedure in 01-132r0.

Participants include: Seagate, LSI Logic, Maxtor, JPM

Umesh has certain hardware that could be useful in exciting the interconnect under test. This round robin will focus on the "Data spewing" card (disk drive card) (renamed in this meeting to SSDB) with a data interface through the SCA connector that allows programming of the data pattern through an HBA using the SCSI transport.


Motion Ham / Umesh that PIP will document a cost effective eye diagram based test methodology for passive interconnect that will be part of a test suite for performance requirements.

Motion passes 10/0.

It was agreed in the August 2001 meeting that a SCSI signal driver board (SSDB) will be used for eye diagram based testing.  This board should be able to control the signal rise time, signal amplitude, fall back level, and possibly other parameters.  A methodology of adjusting the requirements at the receive mask to account for the fact that the SSDB does not deliver the worst case allowed signal will be used.

**10.4 Cable Assembly round robin 1, Martin O., Molex**

[New update in April 2002 see 10.4.2]

The present (20011211) status:
  Foxconn (Jason Chou) complete,  JPM has completed,  Molex complete, next to C&M which is the end.   Some inconsistencies are being found with the attenuation data due to test fixture differences. Significant inconsistencies have been found.  Large contributions to cross talk are coming from the connectors and transition regions in the cable assemblies.

Consensus is that the text fixture design used by Molex should be the documented in PIP for the parametric measurements.  No signal degradation data is available due to lack of SSDB's.   Assumption is that the text fixture for cable assemblies is an SSDB which includes an adapter assembly if required to accommodate the interconnect assembly under test.

[material  after this point is retained in the minutes until transferred to the round robin results document.]

Martin O. presented his view of the content and timing of this round robin.  As there was not enough time to explore all the details in this meeting needed to structure a "good" round robin a reduced, two company round robin will be completed before February 2001.  Martin agreed to structure a preliminary round robin intended to refine the parameters of the real cable assembly round robin 1.  The companies that will deliver results to the February meeting are Molex and JPM.

As this is the first attempt to do a round robin on cable assemblies and since the details of the tests for cable assemblies are still not defined this round robin must be considered as a preliminary investigation of test methods.

**10.4.1 Update / con call minutes review, Martin O., Bob G.**

   **Document contains minutes from two separate teleconference.**

   **Notes by Martin O. from 2/15/01 Teleconference for PIP round robin cable assembly testing .**
   1. Update on the PIP round robin cable assembly:
      a) The following cable assemblies have been received by Molex:

Sample A-[30 (7/38) AWG non shielded flat multidrop Micro Quick
Twist] Hitachi Cable Manchester
2m total length built from a 2m section of the 10m supplied.
500mm center to center drops with a total of 5 HD68 connectors

Sample B-[30 (7/38) AWG non shielded round multidrop]  Madison
Cable Corporation
2m total length built from a 2m section of the 10m supplied. 500mm
center to center drops total 5 connectors HD68 Connectors

Sample C-[30 AWG solid non shielded twisted flat point to point]
Spectra-Strip (Amphenol) (without flats on the ends)
6m total length built from a 6m section of the 20m supplied. VHDCI
connectors on the ends (last resort HD connectors)

Sample D-[30 AWG solid shielded round point to point] Madison
Cable Corporation
6m total length made from 6m of a total of 20m supplied.
VHDCI connectors on the ends.

Sample E-[34 AWG solid shielded round point to point] Temp-flex
6m total length made from 6m of a total of 20m supplied.
VHDCI connectors on the ends.


2.    There were concerns that the idt termination will be damaged
after several repeated plug in and plug out in the course of
testing. A couple of remedies were suggested: 1) To make several
samples with identical characterizations. 2) To use adapters to
protect the damage to the connector/cable termination. 3) To
eliminate damaged lines in the course of the round robin and
collect data only where the lines are in good condition.

3. Impedance Measurement:
   Network analyzer impedance measurement was ruled out as an option
   because of measurement difficulties for the sample lengths.
   Everyone in the meeting agreed to use TDR measurement instrument.
   Also everyone confirmed he or she has TEK 11801 available.

   There was a measurement resolution concern measuring with launch
   signals at 1 ns. It was suggested to add impedance measurement at
   launch signals of 500 ps risetime.

4. Attenuation measurement:
   It was pointed out that the SPI-4 spec recommended attenuation
   measurement with raw cable lengths that can yield 6 dB loss.
   Since the cable assemblies are fixed in length, the group plan to
   come up with measurement method to be reviewed in the next week
   meeting. This was an action item for Molex.

5. Group member update:


**Notes by Zane D. from 12/19/00 conference call as amended in this
meeting.**
1. Discussions on cables to use for the test.
   a. Cable assemblies?
   b. Point to Point!
   c. Multi-drops!

2. Availability of connectors and tooling.

3. Cable shipping packaging and total lengths.
   a. See above

4. Time frame for cable delivery and shipping address.

   a. Send to Bob Gannon
   b. By the 29th of December all samples should be in Bob Gannon's
      hands. Attn:  Mario Sahagun
      JPM Pantera
      Montemorelos No. 121
      Fracc. Loma Bonita
      Zapopan, Jalisco 45060 Mexico

5. Run down of tests to be conducted by Molex and JPM.
   a. Attenuation [1Mhz to 1Ghz]
   b. Crosstalk [NEXT & FEXT - TDR]
   c. Impedance [Diff- first company to test needs to organize a
      conf.  call to discuss test parameters  TDR]
   d. Propagation time [Time Domain TDT] for entire length
   e. Number of pairs to test is 6 pairs.  2 pairs from the center 4
      pairs against the shield.  In the case of flat cable, test 2
      from each edge and ACK and REQ in the inner pairs of the cable.
   f. Basically data pairs 10, 11, 12 & 13 then ACK and REQ pairs.
      However, Bob Gannon can change these parameters if he feels it
      is necessary.  It is requested, though, that we leave ACK and
      REQ in the pairs identified.

6. Time frame for phase 1 cable round robin test.
   a. February 6th is the final deadline for testing
   b. It is requested that JPM and Molex complete the testing by the
      February meeting.
   c. All samples will be sent to Bob Gannon at JPM then built and
      tested by JPM.
   d. Bob Gannon of JPM will forward samples to Martin O. at Molex.
   e. Martin O. of Molex will make fixtures and send them onto Bob
      Gannon by January 5th.
   f. Bob Gannon will need to test and send samples to Martin at
      Molex by the 16th of January (Bob to coordinate other time
      arrangements with Martin). Both JPM and Molex will present
      results at the next meeting in February, schedule in S.
      California.
   g. Ken Plourde Temp-flex to submit sample E to Bob Gannon by
      Friday Feb 23.  Bob will make the assembly and send to Martin
      at Molex by March 02.

The following is detail of Martin O's proposed test procedures for cable
assembly round robin 1.

**Objective:**
This note describes a set of test to characterize the electrical performance of cable
assemblies for the cable assembly round robin test. Test will be conducted at different
locations and data and methods compared for measurement data consistencies. This will be
accomplished by measuring several samples, and results compared later. Most Round-Robin
participant will not be able to conduct all tests, each will do what they can.

**Samples:**
Sample A-[30 (7/38) AWG non shielded flat] Hitachi Cable
Manchester Micro Quick Twist with 2m build sampling 10m
500mm center to center drops total 5 cables HD Cables

Sample B-[30 (7/38) AWG non shielded round]  Madison Cable
Corporation Round non-shielded with 2m build sampling 10m
500mm center to center drops total 5 cables HD Cables

Sample C-[30 AWG solid non shielded round] Spectra-Strip
(Amphenol) Flat Twisted cable (with or without flats on the ends)
with 6m build sampling 20m
Point to point at 6m, VHDCI cables

Sample D-[30 AWG solid shielded round] Madison Cable Corporation
Round shielded cable with 6m build sampling 20m, Point to point at
6m,
VHDCI cables

**Test Parameter:**
a. Attenuation [1Mhz to 1Ghz]
b. Crosstalk [NEXT & FEXT - TDR]
c. Impedance [Diff- TDR]
d. Propagation time [Time Domain TDT] for entire length
e. Number of pairs to test is 6 pairs.  2 pairs from the center,
4 pairs against the shield.  In the case of flat cable, test 2
from each edge and ACK and REQ in the inner pairs of the cable.
f. Basically data pair 10, 11, 12 & 13 then ACK and REQ pairs


**Test Equipment:**
1. Network Analyzer
2.  TDR
2. Molex Proprietary Test Fixtures
4. Coax Test Leads
5. Differential Baluns

**Attenuation:**
Frequency domain Measurement conducted in differential mode.
Record  $S_{21}$ using log scale. Use 30 Hz IF bandwidth. For better
resolution, use 1601 points. Record from 1Mhz to 1GHz. Use Log
frequency sweep. Also record values at 80, 160, 200, and 320 MHz.
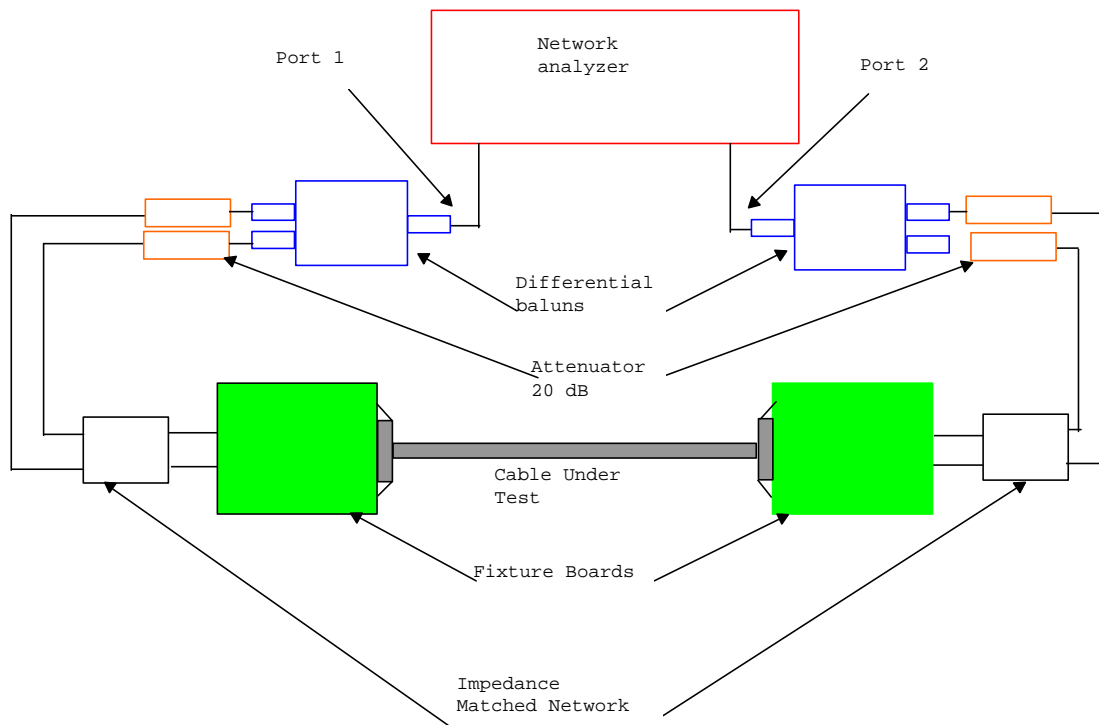
**Test Setup:**

Figure 1 – Test setup

**Test conditions**

A network analyzer is used both as the source of the test signal and as a means of measuring the cable attenuation.

The cal kit contains the precision coax cables and the connector system whose models are stored in the analyzer memory for error correction purposes.

**Test Fixture Board Validation**

Measure the impedance of the test fixture board with a 35 ps launch signal. The impedance of the SMA or launch pad on the board shall remain in the range of 50 to 65 ohms for a 61 ohm controlled impedance board. See fig. 2 for a comparison profile between traditional and acceptable test fixture board impedance for measurements up to 10 GHz signals. For the case of the traditional impedance profile, use matching

impedance network to reduce the effect of the SMA or pad.  The blue
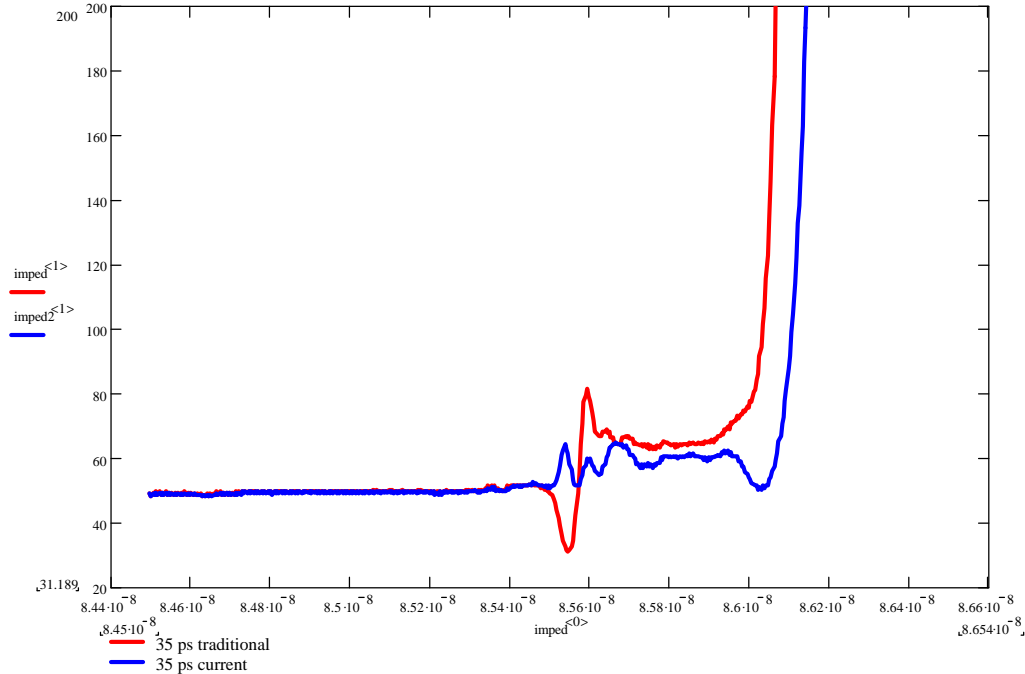curve is acceptable.  The red curve is not acceptable.



Figure 2 - Test board validation

**Measurement Issues:**

For a long electrical delay device such as a cable, the network analyzer  presents some
unusual measurement problems when operating in swept frequency mode. Often the
measured response depends on the analyzer's swept time, and incorrect data may be
obtained. The magnitude of the response can drop at faster sweep rate and look distorted. At
slower sweep rate correct magnitude can be measured. The result may indicate that a cable
has more loss than it truly does or it may indicate presence of ripples which is truly not there.

The cause of the measurement problem arise when using a network analyzer to measure a
devise that has long electrical delay, dt, the device's time delay causes a frequency shift
between it's input and output signals. The frequency shift, df equals the product of the sweep
rate and the time delay.

```
Since frequency is changing with time as the analyzer sweeps, the
time delay of the DUT causes a frequency offset between its input
and output. In the analyzer receiver, the test and reference input
signals will differ in frequency by df. Because the test signal
frequency is slightly different than the receiver frequency, the
analyzer will err in measuring its magnitude or phase. The faster
the analyzer's sweep rate the larger df becomes, and the larger
the error in the test channel.
```

To improve the measurement accuracy, decrease the sweep rate or
decrease the time delay. We will choose to decrease the time
delay. Since the time delay is the property of the test device,
the better thing to do is decrease the delay difference between
the R channel and the B channel. This can be achieved by adding a
length of cable with equal electrical length as the test device.
This length of cable can be inserted between the R channel in and
out connectors on the front panel of the analyzer. The delay of
this cable must be less than 5 usec.

**Differential Impedance:**
The impedance will be measured using a Time Domain Reflectometer
(TDR) system. TDR employs a step generator and an oscilloscope to
capture signal reflections due to device discontinuities. This
test will use a 500 psec risetime step signal for the launch
signal. As the step propagates through the test fixture and the
cable under test, any discontinuities will cause voltage
reflections back into the scope. These reflected voltages are used
to calculate the reflection impedance of the cable under test.

## Test conditions

A Time Domain Reflectometry system (TDR) is used both as the source of
the test signal and as a means of measuring the reflected signals of the
test device.

Two precision coax cables whose characteristic impedance matches the
impedance of the TDR system, are used to connect the test fixture to
the TDR system.

The launched signal is adjusted for 500 psec. risetime.

The schedule and sequence is still under development: the first three are
Molex, JPM (has it now may go back to Molex for new test fixture, and
Madison, Hitachi, Foxconn, TDA, C&M, Tempflex, Amphenol (AIPC)?,
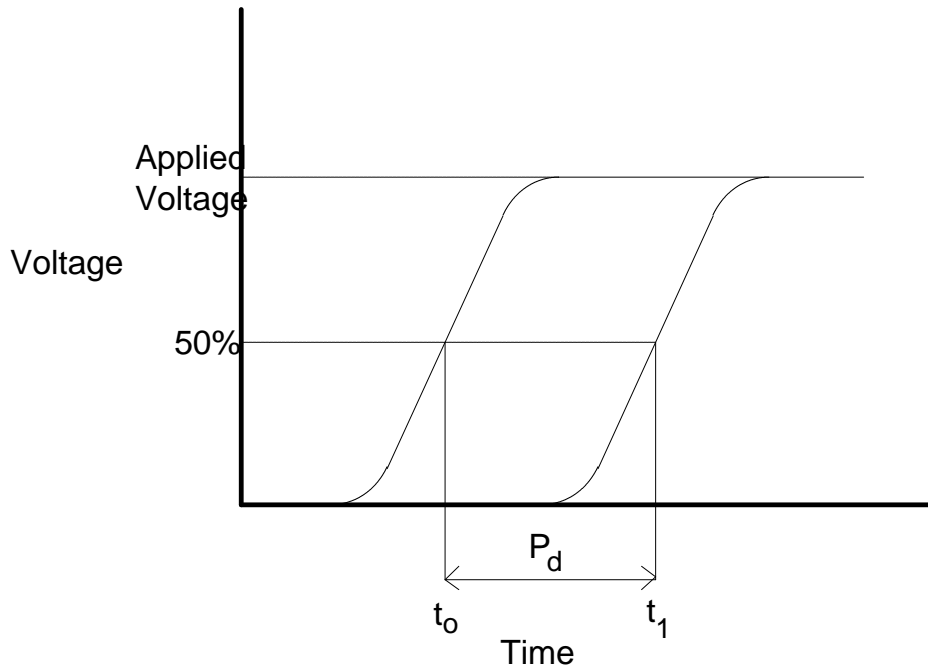
**Propagation Time:**

Figure 3 – Propagation time measurements

Use the TDR to measure the propagation time. Capture the input
signal at the receiver and store in the instrument memory. Connect
the cable assembly and capture the output signal.

The cable propagation delay will be determined by establishing
the difference between $t_0$ and $t_1$ (See fig. 3). This will yield the
cable delay performance.

**Test conditions**
A Time Domain Transmission system (TDT) is used both as the source of
the test signal and as a means of measuring the propagation delay of the
system.

Two precision coax cables whose characteristic impedance matches the
impedance of the TDT system, are used to connect the test fixture to
the TDT system.

The combined test system/fixture step response time should be equal to
or less than the cable step response time.

## Crosstalk:

This test will evaluate the cross talk performance for differential pairs of SCSI cable assemblies.

**Test Conditions:**
Source Signal: 504 mV p-p differential
Source Resistance: 100 ohms differential matched to 122 ohm board trace split differential.
Termination Resistance: 122 ohms split differential
Signal risetime: 500 psec. (20 – 80%)
S:G Ratio based on SPI-4 pin-out
Tek 11801C Scope
Proprietary designed test fixture boards, impedance controlled 61 ohm
Single ended.
Impedance matched risetime filters

**Test Data Presentation:**

| Impedance Ohms (risetime: 500 ps) | | | | |
|---|---|---|---|---|
| Data Lines | Round Cable | Twist/Flat | Twist Only | Comments |
| DB12 | | | | |
| DB13 | | | | |
| ACK | | | | |
| REQ | | | | |
| DB10 | | | | |
| DB11 | | | | |

| Attenuation Round Cable DB/m | | | | | |
|---|---|---|---|---|---|
| Data Lines | 3 dB BW (MHz) | 80 MHz | 160 MHz | 200 MHz | 320 MHz |
| DB12 | | | | | |
| DB13 | | | | | |
| ACK | | | | | |
| REQ | | | | | |
| DB10 | | | | | |
| DB11 | | | | | |

| Attenuation Twist/Flat DB/m | | | | | |
|---|---|---|---|---|---|
| Data Lines | 3 dB BW (MHz) | 80 MHz | 160 MHz | 200 MHz | 320 MHz |
| DB12 | | | | | |
| DB13 | | | | | |
| ACK | | | | | |
| REQ | | | | | |
| DB10 | | | | | |
| DB11 | | | | | |

| Attenuation Twist Only DB/m | | | | | |
|---|---|---|---|---|---|
| Data Lines | 3 dB BW (MHz) | 80 MHz | 160 MHz | 200 MHz | 320 MHz |
| DB12 | | | | | |
| DB13 | | | | | |
| ACK | | | | | |
| REQ | | | | | |
| DB10 | | | | | |
| DB11 | | | | | |

| Propagation Time Round Cable (ns) | | | | |
|---|---|---|---|---|
| Differential Pair | Conductor 1 | Conductor 2 | Propagation Time | Propagation Time/Meter |
| DB(12) | 1 | 35 | | |
| DB(13) | 2 | 36 | | |
| ACK | 24 | 58 | | |
| REQ | 29 | 63 | | |
| DB(10) | 33 | 67 | | |
| DB(11) | 34 | 68 | | |

| Propagation Time Twist/Flat (ns) | | | | |
|---|---|---|---|---|
| Data Line | Conductor 1 | Conductor 2 | Propagation Time | Propagation Time/Meter |
| DB(12) | 1 | 35 | | |
| DB(13) | 2 | 36 | | |
| ACK | 24 | 58 | | |
| REQ | 29 | 63 | | |
| DB(10) | 33 | 67 | | |
| DB(11) | 34 | 68 | | |

| Propagation Time Twist Only (ns) | | | | |
|---|---|---|---|---|
| Data Line | Conductor 1 | Conductor 2 | Propagation Time | Propagation Time/Meter |
| DB(12) | 1 | 35 | | |
| DB(13) | 2 | 36 | | |
| ACK | 24 | 58 | | |
| REQ | 29 | 63 | | |
| DB(10) | 33 | 67 | | |
| DB(11) | 34 | 68 | | |

| Cross Talk (Differential) Rise time (20-80%): 500 ps | | | | | | | |
|---|---|---|---|---|---|---|---|
| Differential Pair | | Round Cable | | Twist/Flat | | Twist Only | |
| Driven | Victim | NEXT % | FEXT % | NEXT % | FEXT % | NEXT % | FEXT % |
| 24, 58 | 29, 63 | | | | | | |
| 1, 35 | 2, 36 | | | | | | |

Bob Gannon agreed to attempt to define a signal degradation test based on eye diagrams and with independent aggressor signals operating during the acquisition of the primary pair under test eye.


**10.4.2 Status of cable assembly round robin 1**

[As reported in April 2002:]

As of October 2001 Three reports have been issued: Two from Foxconn and one from Molex.  Significant disagreement was found in the attenuation, impedance, and cross talk data.  Reasonable agreement was found for propagation time.  Cables are presently at Molex and will be shipped to C&M for further testing.

It appears that the Foxconn test fixture, which did not follow the specifications for the test fixture, is the main source of the disagreement.  C&M's test fixture should comply with the requirements.

**10.5 Frequency dependence of dielectric constant test methodology round robin - Barnes, LSI Logic; Vaupotic, Spectra strip**

[April 2002 meeting status: due to unlikely further work this round robin is hereby declared suspended until further notice.]

Deferred (again) to some indeterminate future time due to the departure of Larry Barnes from LSI Logic.

This work is intended to use the HP polished probe method according to the following table.  A round robin is planned when the method is stabilized.

Greg Vaupotic provided swept frequency data from the slab method for several samples.  The samples in both pellet and extruded form along with data were provided to Larry B.

This discussion produced collaboration containing the following:

| Pure polyethelyne samples to be provided by Spectra Strip (unlikely to be affected by processing) | slab method data from Spectra Strip's supplier measurements | coax probe method from LSI Logic measurements |
| --- | --- | --- |
| raw material processed into a slab | Spectra strip | NA due to slab samples no longer existing |
| raw material extruded over single conductor 30 AWG with approximately 10 mils dielectric thickness | NA | LSI logic -- strip material off conductor and measure by inserting the probe through slit in the conductor to the opposite side |

The range of frequency will be at least 1 MHz to 1 GHz linear sweep.

The samples and slab data have been delivered to Larry.

Greg Vaupotic and Larry Barnes are actioned to complete the work outlined in the above table.

## 11. Proposed new round robins

No new round robins were proposed this meeting.  See however, the next item.

## 12. PIP documentation - Daggett

### 12.1 Actions required to produce a ballotable PIP document, group

Discussion about how to produce a ballotable PIP document was again undertaken.  A serious push is being mounted to get the document completed within the next couple of months.  Larry Barnes has been doing some editing in his spare time – Thanks Larry.

Enough material has been gathered to enable creation of a credible document but some paring needs to happen.  Editing sessions were scheduled at two week intervals for the next six weeks.  See section on meeting schedule for details.

At the next meeting specific section of the document will be assigned to individual editors.  A number of people have indicated willingness to help so there now a better chance of getting the document finished.

### 12.2 Definitions for the document - Barnes

Not addressed at this meeting.

### 12.3 Conversion of the document into Frame from Word.

Thanks to Larry Barnes and Bill Ham the existing revision of PIP and the new material from the minutes was completely converted into Frame 6.0 at the December meeting.  Since then significant work has been completed on the conversion.  The remaining conversions needed are a few figures that Bill Ham will complete before the next editing session.

### 12.4 Report from last editors meeting

Not done due to lack of time.

### 12.5 Document review, Zane

Not done due to lack of time.

## 13. Old business

### 13.1 SSDB position for PIP

The PIP methodology for interconnect assemblies depends critically on having an SSDB for producing the signals.  With the departure of Larry Barnes from LSI Logic it is not clear whether LSI Logic will actually supply an SSDB to the industry.  Seagate indicated that they are willing to supply an SSDB if needed.  Therefore, since PIP needs to have a working framework the following motion was formally made:

Motion, Ham/Daggett, that PIP will be developed with the assumption that an SSDB will be available to use with the measurements that require it.

Motion passes unanimously.

## 14. New business

### 14.1 Far end cross talk?

After significant discussion it was decided that FeXT would not be a level 1 requirement for bulk cable.  The FeXT performance is addressed by meeting the near end cross talk, the impedance, and other level 1 requirements.

## 15. Next meetings

PIP is always scheduled in conjunction with SSM-x.  An editing session is always included for one or the other project.  PIP and SSM alternate in terms of which is first and which is second.  The editing day is either before or after the contiguous PIP/SSM days and is identified in the schedule.  To get this started SSM precedes PIP in February 2002, PIP precedes SSM in April 2002, etc.

Approved schedule:

April 19, 2002 (Fri) 9AM to 5PM, Compaq plant, Shrewsbury, MA (editing)

April 30, 2002 (Tues) 9AM to 5PM, Nashua NH (Hitachi) (editing)

May 17, 2002 (Fri) 9AM to 5PM, Compaq plant, Shrewsbury, MA (editing)

June 03, 2002 (Mon) 9AM to 5PM, Compaq plant, Shrewsbury, MA (editing)

June 20, 2002 Lisle, IL (Molex) - (06/18 is editing for SSM, 06/19 is SSM)

Requested schedule:


Aug 13 Southern CA (Actuone - parent to Foxconn)  13 PIP editing, 14 PIP
15 SSM

October 15, 2002 Worcester MA (Madison) 15 SSM editing, 16 SSM, 17 PIP

December 03, 2002 Guadalajara, Jalisco, MX (Electronica Pantera) 03 PIP
editing, 04 PIP, 05 SSM



**16. Action Items:**


**16.1 Old action items from previous meetings**


Zane to provide a methodology specification for the HP slab method for
dielectric constant vs. frequency
Status: overcome by events - changed to a level 2 measurement - no
further work anticipated

Bill Ham to post the draft minutes to the T10 web site
Status: done 02-082r0

Larry Barnes to place his spreadsheet relating to effects of periodic
structures on the T10 web site.
Status: file has been recovered from an older rev - posting expected
soon

Greg V to create 01-130r1 containing the essence of the Seagate results
relating to effects of sample length on impedance.
Status: carried over

Ham to create a draft of the overview section for the PIP document
Status: significantly progressed - needs review


Larry presented approximately 20 sources of material that relate to PIP
measurements.  Larry is actioned to combine these files into a single
file and post on the T10 site.  Folks are encouraged to look at theses
references and determine if any content is relevant to the PIP project.
Status: non-copyrighted material was posted -- Larry will provide his
original list (in whatever form it exists).
Status: carried over

Action to chair to contact Bill Weurtz of LSI Logic to determine future
activity on action items previously assigned to Larry Barnes
Status: contact made but no conclusion yet

Umesh to propose a set of tests to be used for backplane S21
measurements.
Status: carried over

**16.2 New actions from this meeting**

Bill Ham to post the minutes to the T10 web site
Status: new


**17. Adjourn**

The meeting adjourned at 5:00PM on April 03, 2002