Passive interconnect performance working group (PIP) 01-074r0
February 20, 21, 2001
Cypress, CA

Subject: Draft minutes for the SCSI passive interconnect performance working group, PIP, in Cypress, CA on February 20 ,21, 2001

Zane Daggett of Hitachi, chair led the meeting. Bill Ham of Compaq, secretary, took these minutes. There was a good attendance from a broad spectrum of the industry. Jason Chou of Foxconn hosted the meeting.

Previous approved minutes: 01-019r1

## 1. Introduction

In the absence of both Zane Daggett and Dave Chapman, Bill Ham, secy, opened the meeting, conducted the introductions, and reviewed the meeting purpose.

## 2. Attendance

The following folks were present:

| Name | Organization | e-mail | Phone |
|---|---|---|---|
| Dave MacQuown | Adaptec | david_macquown@adaptec.com | 408-957-6749 |
| John Bauer | Amphenol | John.bauer@amphenol-usa.com | 510-656-8330 |
| Bill Ham | Compaq | Bill_ham@ix.netcom.com | 978-828-9102 |
| Jason Chou | Foxconn | jasonc@foxconn.com | 408-919-6141 |
| Frank Quach | Foxconn | frankquach@foxconn.com | |
| Pei Tsao | Foxconn | Pei.tsao@foxconn.com | |
| Zane Daggett | Hitachi Cable | zdaggett@hcm.hitachi.com | 603-669-4347 x.236 |
| Bill Troop | IBM | troop@us.ibm.com | 919-254-2695 |
| Bob Gannon | JPM | rgannon@jpmco.com | 860-537-6800 |
| Larry Barnes | LSI Logic | Larry.barnes@lsil.com | 719-533-7432 |
| Jie Fan | Madison Cable | Jie.fan@madisoncable.com | 508-752-2884 x 306 |
| Martin Ogbuokiri | Molex | mogbuokiri@molex.com | 630-527-4370 |
| Ken Plourde | Temp Flex | kplourde@tempflex.com | 508-839-5987 x.232 |
| Brett Philip | Temp-Flex | brettphilip@home.com | 503-57-2025 |
| Paul Aloisi | Texas Instruments | paul_aloisi@ti.com | 603-429-8687 |
| Don Getty | Texas Instruments | donald_getty@ti.com | 408-246-3100 Ext. 41 |

## 3. Agenda development

The agenda shown was that used (moved by Ham / Daggett). Passed unanimously.

## 4. Approval of previous minutes

Bill Ham moved and Zane Daggett seconded 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: | Dave Chapman, Amphenol |
| Secretary: | Bill Ham, Compaq |

Document editors: Zane Daggett, editor in chief,  Bill Ham, assistant editor, Greg Vaupotic, assistant editor, others welcome (but work is expected)

## 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 first meeting with the next meeting scheduled for T11 week in February.

## 8. Presentations on new topics

None

## 9. Effects of non-uniformities and/or periodic structures

### 9.1 Effects of periodic structures continued, Larry Barnes, LSI Logic

[not discussed in February]

Larry presented a spread sheet that reports the loaded impedance and velocity of propagation based on frequency, unloaded impedance, separation of loads, capacitance of loads assuming no stub length. Larry agreed to make this spreadsheet available on the web.

Larry Barnes is actioned to place his spreadsheet on the T10 web site.

## 10. Rationalization of existing attenuation data, all

[This table was not updated but the information regarding the ways to measure attenuation is important and needs to be in a section of the document.]

The table generated in the last meeting was re-examined. A summary of the data available at meeting time is given in the table below.

The data in the table is for cable assemblies or media only, media impedance varies in the 128-132 ohm range, data presented in units of dB/m, fail limit set at 12 dB @ 25m @ 200 MHz in SPI-3. Note that there are significant differences in the measurement methodologies and that direct comparisons may not be valid. Nevertheless, the data presented shows the magnitude of difference that has been reported. This framework will be used to compare the round robin data.

| | Seagate<br>HP 8110 pulse generator with clock-like pattern with slow edges, spectrum analyzer used for measuring outputs and inputs | Hitachi<br>network analyzer with 100 ohm baluns | Madison<br>4-port network analyzer | Amphenol twisted pair ribbon (no flats) network analyzer with TP101 with 121Ω matching pads |
|---|---|---|---|---|
| Sample description | cable assys | cable media | cable media | cable media |
| 80 MHz | | | | |
| 30 strand | | 0.32/m (8/25m) | 0.31/m (7.75/25m) | |
| 30 solid | 0.16/m?? (4/25m) media type not known for sure at time of writing | 0.26/m (6.5/25m) | | TPE 0.26dB/m (6.5/25m) |
| 28 strand | 0.12/m (3/25m) | 0.19/m (4.75/25m) | | |
| 28 solid | | | 0.25/m (6.25/25m) | |
| 200 MHz | | | | |
| 30 strand | | 0.59/m (14.75/25m) | 0.52/m (13/25m) | |
| 30 solid | 0.38/m?? media type not known for sure at time of writing | 0.44/m (11/25m) | | TPE 0.46dB/m (11.5/25M) |
| 28 strand | 0.28/m (7 dB/m) | 0.36/m (9/25m) | 0.40/m (10/25m) | |
| 28 solid | | | 0.40/m (10/25m) | |

Note that there are few direct comparisons and some minor inconsistencies in the data in the above table. There is considerably more than the wire gauge that influences the attenuation. Thus the wisdom of doing a performance rather than a physical description specification.

Nevertheless, the present specification of 12 dB @ 25m @ 200 MHz seems to be reasonable given the 11 dB/25m data for 30 AWG solid.

It was noted that the Seagate data has backed out the d.c. contribution which is a couple of dB. This helps the agreement considerably.

## 11. 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.

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

### 11.1 Cable media round robin 2 (Expanded parameter set), Greg Vaupotic, Amphenol Spectra Strip

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

**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).

**SAMPLES**

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)

## ATTENUATION

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 Ω shunt and two 47 Ω 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 Ω ± 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 Ω environment.

**Method D** Full 4-port calibration. Calibrate for 122 Ω 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 Ω 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<br>(203) 287-8725 | 720 Sherman Ave<br>Hamden CT 06410 | greg.vaupotic@snet.net |
| Hitachi Cable | Zane Daggett<br>(603) 669-4347 | 900 Holt Avenue<br>Manchester NH 03109 | zdaggett@hcm.hitachi.com |
| Madison Cable | Jie Fan<br>(508) 752-2884 | 125 Goddard Memorial Dr.<br>Worcester MA 01603 | jie.fan@madisoncable.com |
| Seagate | Umesh Chandra<br>(831) 439-7264 | 4585 Scotts Valley Drive<br>Scotts Valley CA 95066 | Umesh_chandra@seagate.com |
| Adaptec | Dave MacQuown 408 957-6749 | 691 South Milpitas Blvd, Milpitas CA 95035 | david_macquown@corp.adaptec.com |
| END Amphenol Spectra-Strip | Greg Vaupotic<br>(203) 287-8725 | 720 Sherman Ave<br>Hamden CT 06410 | greg.vaupotic@snet.net |

## TEST METHOD CAPABILITIES

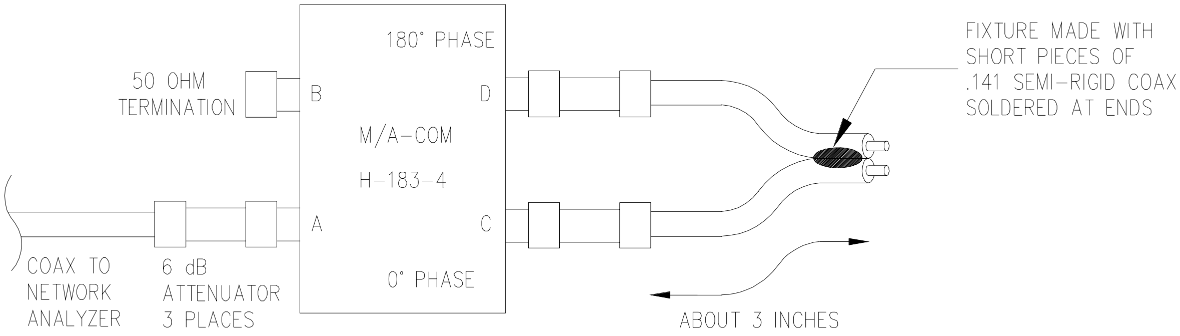
Table below shows anticipated test capabilities of participants.

| Company | Balun A | Balun B | 4-port C | 4-port D | Hybrid E | "4-port" F |
|---|---|---|---|---|---|---|
| Amphenol | yes | yes | no | no | yes | no |
| Hitachi Cable |  |  | no | no |  | no |
| Madison Cable | Yes? | yes? | yes | yes |  | yes |
|  |  |  |  |  |  |  |
| Seagate | yes | yes | yes | yes | yes | yes |
| 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.



### 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 <u>differential</u>. Multiply measurements by two for <u>differential</u> 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:

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

### 11.1.1 Status of cable media round robin 2

Greg Vaupotic received the samples from Hitachi and from Madison. These samples were added to the sample supplied by Spectra Strip.

Testing has been completed at Spectra Strip and has forwarded the samples to Hitachi, Madison will receive the samples by Feb 23, 2001.

All samples are 25 meter length.

Hitachi Cable Manchester: Sample 1

Round twisted pair cable having overall shield, 28 AWG 7-36 TC (Hitachi)

Prep both ends:

pair 1 (Heat shrink 1),
pair 7 (Heat shrink 2),
and pair 34 (Heat shrink 3) (each pair to be secured with heat shrink tubing)

Madison: Sample 2

Round twisted pair cable having overall shield, 30 AWG solid TC (Madison)

Prep both ends:

pairs

1 (Heat shrink 1),
7 (Heat shrink 2),
and 34 (Heat shrink 3) (each pair to be secured with heat shrink tubing)

Spectra-Strip: Sample 3

Twisted pair ribbon having no flats, 30 AWG Solid TC

Zane: Sample 4

Twisted pair ribbon having flats at 250mm intervals (Hitachi)

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

[most of this is a carry over from the last meeting - some significant progress has been made however]

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 has a non-product backplane design that could be used. Bill Ham thinks that he may have some older backplanes that are not products that could be used.

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

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

Umesh is actioned to propose a set of tests to be used including things like test fixtures and specific slots to be measured.

Participants include: Seagate, Compaq?, Adaptec?, IBM?, Quantum?,

Umesh has certain hardware that could be useful in exciting the interconnect under test. The initial cut should focus on the "Data spewing" card (disk drive card) with a data interface through the SCA connector that allows programming of the data pattern through an HBA using the SCSI transport. Umesh is actioned to determine if/when the data spewing card could be made available to the industry for use in PIP applications.

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.

### 11.3 Cable Assembly round robin 1, Martin O., Molex

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.

### 11.3.1 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 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.

b) The following have not been received as of date:

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 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:

Jie Fan of Madison Cable requested to replace Chuck Grant name with hers from now on. Also, Jason Chou of Foxconn has asked to participate in the cable assembly round robin test.

**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!

  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. 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

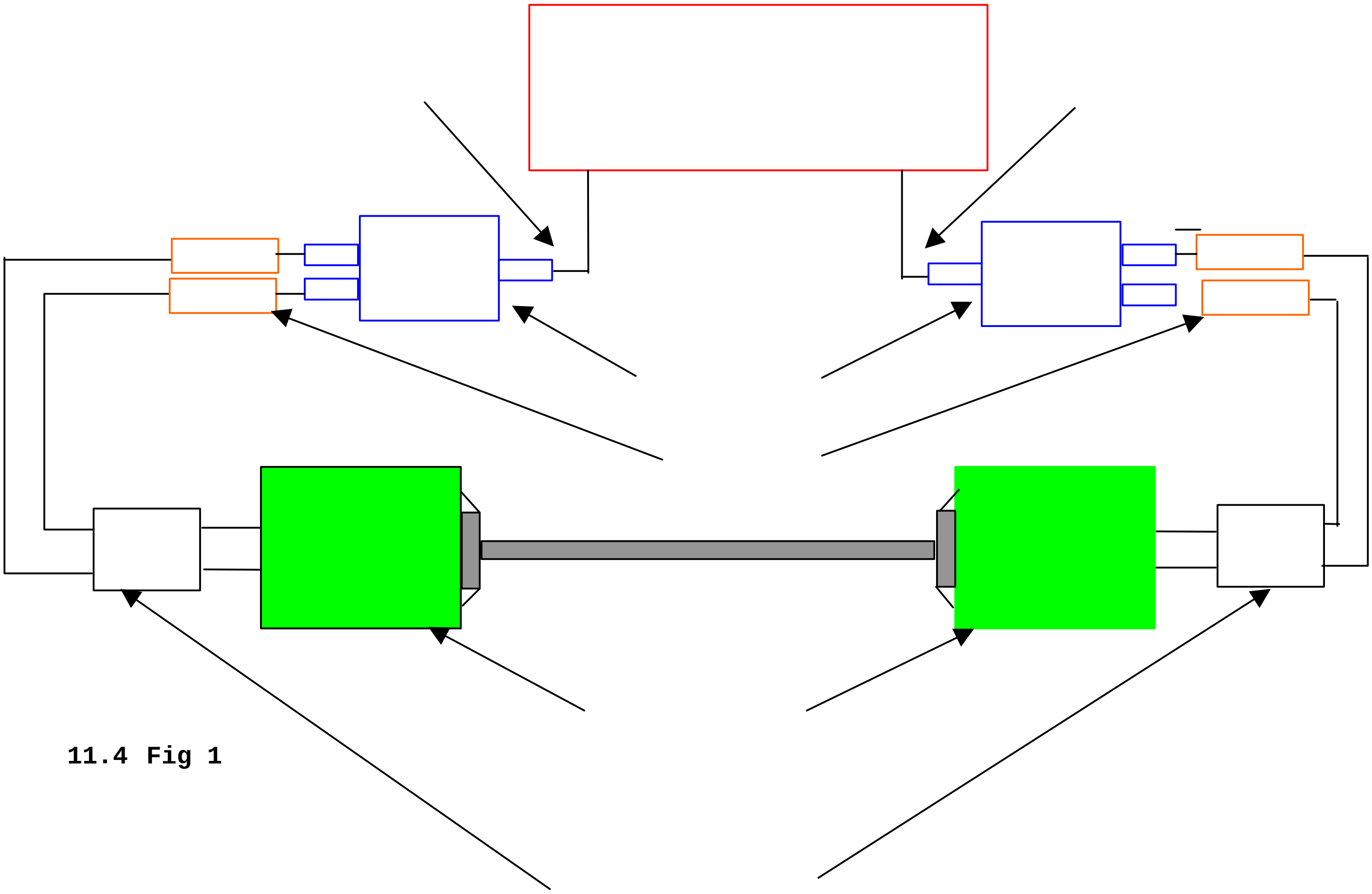
**Test Parameter:**

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:**



**11.4 Fig 1**

**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 will 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.

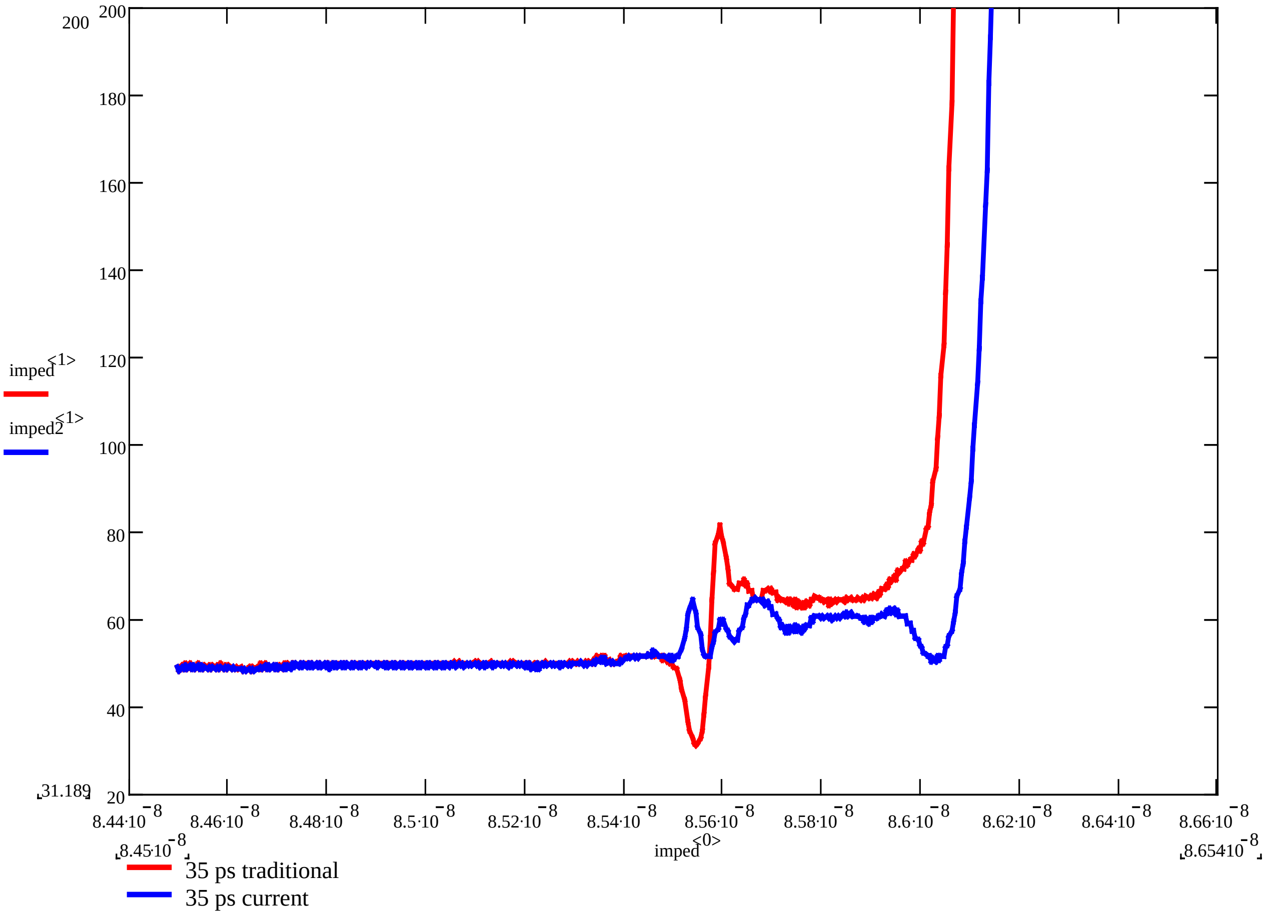


Fig. 2

**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.

## 12. Propagation Time:

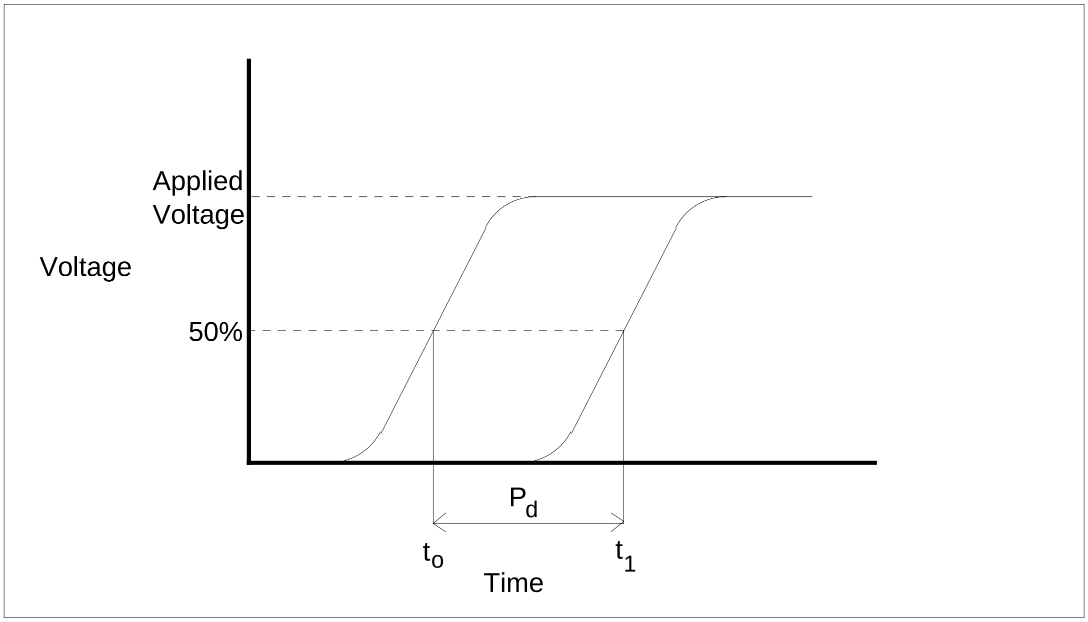


**Fig 3**

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

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

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

| Attenuation<br>Twist Only<br>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)<br>Rise time (20-80%):<br>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.

## 13. Proposed new round robins

## 14. Frequency dependence of dielectric constant test methodology - Barnes, LSI Logic

Deferred (again) to April due to scheduling issues with Fisher Scientific. 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 noted that data from the swept frequency slab method on partially processed material could be made available.

This discussion produced collaboration containing the following:

| Polyethelyne samples to be provided by Spectra Strip | slab method | coax probe method |
|---|---|---|
| raw material processed into a slab | Spectra strip | LSI Logic |
| raw material extruded over single conductor 26 AWG with approximately 12 to 15 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 (C-) |
| material removed from conductor processed into slab | Spectra strip | LSI Logic |

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

The samples will be targeted to Larry by mid November 2000.

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

## 15. Worst case vs spec numbers strategy

[This item was not discussed at this meeting but is still unresolved.]

This item is intended to address the basic issues created by using a collection of worst case component specifications instead of recognizing the typical integrated impact of a collection of real parts.

Worst case specifications frequently result in excessive demands to improve component performance. On the other hand, given a large population of components, there is some chance that end-to-end failures will be experienced unless the worst case component performance requirements are met.

Therefore, conditions for SCSI are approaching the point where some recognition of the overspecification that results from worst case methodologies is reflected in the component performance specifications. When the worst case numbers are added up for SPI-4 the SCSI segment will not work. Therefore, either the specification methodology or some component specifications need to change.

This is one reason why there is presently a focus on the interconnect specifications.

In any case there were no breakthroughs in this area at this meeting.

## 16. SCSI passive interconnect as an N-port construction - all

[This section was discussed in earlier meetings but will be retained in the minutes until transferred into the PIP document.]

It was previously agreed that the SCSI cable assembly will be considered as an N’-port element where every connector constitutes the approximate location of the ports. Since SCSI is a parallel bus every connector contains a multiplicity of somewhat independent ports (one for every differential signal).

For purposes of the SPIP work a lower case “N”, n, refers to the number of the specific signal in a connector. An upper case “N’”, N’ refers to the number of a specific connector. Thus a SCSI passive interconnect is characterized by N’ connectors and n signals. N’ is used instead of N so that when referring to connectors or ports verbally there will be distinction. Typically n ranges from 1 to 27 for SCSI applications. N’ is determined by the structure of the interconnect and ranges from 2 to 18 (16 devices + 2 terminators) in most cases.

Therefore, a SCSI passive interconnect many contain up to 18 x 27 = 486 ports. Each N’th port can be represented by a matrix of n ports. The structure of the matrix will be based on the names of the signals.

Each port is characterized by (1) the signal launched into the port and the signal reflected back from the launched signal (2) the signal transferred to the port from other ports in the cable assembly.

The signals delivered out of every port when the most degraded allowed signal is launched from every other port (one at a time), when the most aggressive noise sources are present on all other ports that can couple into the port under test, and when the resonant conditions are within acceptable bounds shall meet at least the minimum requirements for a received signal.

## 16.1 Local neighborhood concepts

[This section was discussed in earlier meetings but will be retained in the minutes until transferred into the PIP document.]

For signals, the basic idea is to not test for interactions that are insignificant to the port under test. For example in a flat cable signals removed from the signal under test by at least 5 signal pairs do not significantly couple into the signal under test and do not need to be considered. The level of interaction deemed to be significant is left to be defined.

For physical constructions the dimensional precision within which the construction shall be considered identical is 1/10 of the rise length of the fastest signal to be used in the interconnect. This is approximately 1 inch for 1ns rise time signals in shielded twisted pair media. In other words, two connectors placed 0.5 inch apart may be treated identically regardless of which is actually tested. Similarly, the placement of connectors on nominally identical flat ribbon cables shall be considered identical if they are within 1 inch of being at the same position.

## 16.2 Length measurements

[This section was discussed in earlier meetings but will be retained in the minutes until transferred into the PIP document.]

The length of the interconnect needs to be understood. For example there are a few percent difference between different “length” parameters. For example it may require 103 feet of wire to produce a cable assembly with 100 feet overall connector to connector path length. (2-103 foot wires to produce a single 100 foot twisted pair). Cabling applied to a bundle of pairs (cable lay) also affects the total path length.

The electrical length is also important where the propagation time is part of the interest for the specification.

The following was proposed as the way that PIP will consider length issues:

That the length parameters be separated into two pieces both of which shall be specified:

(1) the physical length along the geometrical center line (e.g. center line of the jacket for round cables to the center line of the unmated connector) of the completed cable assembly (not necessarily the actual wire length for any specific conductor)

(2) the propagation time between electrical access points (typically connectors) in the cable assembly

Other lengths such as those internal to the media will NOT be used as descriptors in PIP. These internal lengths may be important for creating accurate models but are not essential to specify how to do proper measurements on cable assemblies and therefore do not belong in the PIP effort.

## 16.3 Interoperability points

[This section was discussed in earlier meetings but will be retained in the minutes until transferred into the PIP document. Bill Ham extracted this section and presented it at the last SCSI plenary, 00-404r0. A version suitable for use in the SSM document resulted.]

Interoperability points are physical points in the system where separable connectors exist and where it is required that the components on either side of the connector may be supplied from different compliant vendors. Following is a list where interoperability might be expected in a SCSI segment. A “Y” following the position designation means that this will be considered an interoperability point for PIP purposes. Similarly, a “N” following the position designation means that the point will NOT be considered an interoperability point for PIP purposes.

Disk drive connector mounted directly on the disk drive (Y)

HBA connector external connector (Y)
HBA internal SCSI connector to internal cables (Y)
HBA internal SCSI connector to the mother board (N)

Motherboard SCSI connector where the mother board contains the HBA (in an ASIC) on board (Y)

Backplane connectors:

> Any connector that directly accepts a disk drive or other SCSI device (Y)
>
> Any connector that directly connects to an external cable assembly through an expander on the backplane (Y)

Any connector on an external cable assembly that connects to an external connector of an HBA (Y)

Any connector on an external cable assembly that connects to an external connector of a disk drive array containing an expander immediately behind the external connector (Y)

Any connector on an internal cable that directly connects to a disk drive or other SCSI device. (Y)

Question: should the external connector to a disk drive array that does not contain an expander be considered an interoperability point? The group agreed that this should NOT be an interoperability point until proven otherwise in the SSM group. (N)

The external connector to a box that has external cable assembly attached and an internal cable assembly attached internally to the same connector. (N)

Note: this means that one may NOT have a cable to cable connection at the bulkhead if interoperability is required.

Question: should separable connectors that belong to terminators be considered interoperability points? The group agreed that these connectors should be included in the interoperability suite.(Y)

### 16.4 Approach to concatenated constructions

[This section was discussed in earlier meetings but will be retained in the minutes until transferred into the PIP document.]

The group identified two basic situations:

In the first situation the SCSI passive interconnect performance is considered under the conditions where the bus segment interconnect consists of a single media type and construction. For example, in this situation, two dissimilar (e.g. round to flat) cable assemblies connected together in series would not have an interoperability point at the point of common connection. Similarly, a backplane connected directly to a round shielded cable would NOT have an interoperability point at the backplane connector.

While the first situation is relatively easy to construct performance requirements around, it leaves several important constructions without clear definition.

Thus the second situation:

Four examples are described where interoperability is probably expected in common constructions:

- where a short cable assembly is used between the HBA and the bulkhead in a PC-like packaging
- where a short cable assembly is used between the disk drive and the backplane
- where an HBA is used between the external bulkhead and both internal and external cables
- where an external cable is attached directly to a backplane

Each of these cases has the property that the performance at the connector is significantly affected by the details of the passive interconnect on BOTH sides of the connector. This complicates specifying unique performance requirements the connector because of interactions on both sides.

Because these are important practical applications, some approach is needed in the PIP work. This subject is left for further consideration by the modeling group and in future PIP efforts. Pending definition of a viable strategy for these situation 2 cases work in PIP will be focused on the situation 1 cases.

## 17. Project proposal for PIP - all

Bill Ham noted that the project proposal for PIP was approved at the T10 plenary in May. The project proposal is document number 00-238r0. The project number 1439-D. This numbering implies that PIP is a standard and not a technical report. Bill Ham is actioned to check this out.

Motion Ham/Vaupotic that the PIP ad hoc recommend to the T10 plenary that the PIP project be to develop a standard (if that is not already the case).

6 in favor, 0 opposed, 3 abstain.

Action to Zane to post a reflector note indicating a T10 plenary vote to change project 1439-D (PIP) from a technical report to a standard.

Action to Ham to create a modified SD3 for PIP as a standard.

## 18. PIP documentation - Daggett

This working group will proceed to develop an internal committee document Titled: “SCSI Passive Interconnect Performance Requirements” whose schedule is independent from SPI-x standards schedule. Zane Daggett is editor, Bill Ham and Greg Vaupotic are assistant editors. The document will follow the same general format as 99-219rx.

The document number is 00-160rx.

### 18.1 Topics for consideration for the passive interconnect test document

[This section was discussed in earlier meetings and modified slightly in this meeting. It will be retained in the minutes until transferred into the PIP document.]

The material in this section was reviewed from the last meeting as possible candidates for consideration for the PIP document 00-160rx.

#### 18.1.1 Components of passive interconnect

The following constitute the basic building blocks of passive interconnect:

media (wire and backplane)
connectors
transition regions (connector termination / comb out / lacing regions / vias)

### 18.1.2 Construction

The following physical constructions are part of PIP:

Point to point:
- two connector shielded
- two connector unshielded

Multidrop:
- multi connector shielded (e.g. external daisy chain)
- multi connector unshielded
- multi connector backplanes

Stubs:
- backplane stubs (length of conductor extending beyond a terminator)
- device circuit board stubs
- unshielded cable stubs
- shielded cable stubs

Overall length and specific placement and properties of stubs are essential parts of the description of the construction. Note that the length and position may not be measured in inches but rather in nanoseconds.

In general the passive interconnects for SCSI are complex multiport circuits whose performance must be considered from every connector in the interconnect.

### 18.1.3 Specific technical concentration areas

- Cable assembly design
    - Non uniform media issues (e.g. twisted flat)
    - Transition regions for cable assemblies
    - Connector performance specifications
    - Connector variations
    - Assembly construction variations
- Backplane design
    - Distance between connectors
    - Trace impedance
    - Overall backplane size constraints
    - Power and ground distribution
    - Routing restrictions (e.g. no traces over breaks in power/ground planes)
    - Holes for cooling air
    - Mechanical rigidity
    - EMC containment
    - Effect of vias
    - Effects of connector attachment scheme (vias, pads)
    - Proximity effects of extraneous materials near the signal paths
    - Et cetera

- EMC - reference SFF-8410 for CMPT and EMR for emissions - applies to shielded versions only
    - Susceptibility issue for backplanes?

### 18.1.4 Test types

[The material below has been substantially transferred to the document and will be retained until the first draft of the document is posted. The material below may not be accurate as the document was reviewed and some changes are captured there.]

The following table represents the present view of the candidate measurements

Table 1 Summary table for test parameters for SCSI PIP

| Test parameter | Level | Applicability (cable media, backplane, modeling, etc.) | Section | Domain | Condition | Sample configuration | Comments |
|---|---|---|---|---|---|---|---|
| **SE local impedance** | **1** | All | | T | | | |
| **Diff local impedance** | | All | | | | | |
| **Extended Distance Impedance (Diff)** | | Cable media | | F | | | |
| **Capacitance (SE)** | | Cable media, interconnect assembly (L2), backplane, modeling | | F | | | |
| **Capacitance (Diff)** | | Cable media, backplane, modeling | | F | | | |
| **Propagation time** | | Cable media, interconnect assembly (L2), backplane, modeling | | T | | | Within the pair |
| **Propagation time SKEW** | | Cable media, interconnect assembly (L2), backplane, modeling | | T | | | Pair to pair |
| **Eye diagrams (signal degradation)** | | Interconnect assembly | | T | | | All lines active |
| **NEXT** | | Cable media, interconnect assembly, backplane, modeling | | T | | | |
| **FEXT** | | Cable media, interconnect assembly, backplane, modeling | | T | | | |
| **EMI** | | Interconnect assembly | | F | | | Shielded versions only |
| **D.C. leakage to ground** | | Interconnect assembly | | | | | [Impacts receiver bias / D.C. offset] |
| **HI-Pot** | | Cable media, interconnect assembly, backplane | | | | | |
| **D.C. resistance imbalance** | | Interconnect assembly | | | | | Within the pair |
| **Dielectric constant variation w/ frequency** | | Cable media, backplane, modeling | | F | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Common mode impedance** | **2** | Cable media, backplane, modeling | | T | | | Treat each pair as a single conductor |
| **Common mode capacitance** | | Cable media, backplane, modeling | | F | | | |
| **Propagation time** | | Cable media, modeling | | F | | | Within the pair |
| **Propagation time SKEW** | | Cable media, modeling | | F | | | Pair to pair |
| **Eye diagrams (signal degradation within the pair)** | | Interconnect assembly, modeling | | T | | | One line active |
| **Common mode degradation** | | Interconnect assembly, modeling | | T | | Need more discussion on whether this is level one or level two type test. | + Signal to - signal balance within the pair (sum of the difference) |
| **Attenuation (within the pair)** | | Interconnect assembly, media, backplane | | F | | | |
| **Attenuation skew (pair to pair)** | | Interconnect assembly, media, backplanes | | F | | | Difference in voltage transfer function between pairs |
| **Rise time degradation** | | Interconnect assembly, modeling | | F | | | The pair propagation velocity |
| **~~Common mode noise~~** | | | | | | | |
| **Dielectric constant variation w/ frequency** | | Cable media, backplane, Modeling | | F | | | |
| **ACR (attenuation to cross talk ratio)** | | Cable media, Modeling | | F | | | |
| TBD | | | | | | | |
| **Vector Network Analyzer (VNA) tests???** | | Modeling | | | | | All matter of S parameters. |
| | | | | | | | |

[0] Create a definition field for each "media" Cable media, Interconnect assembly, Backplane, Modeling, etc.

Interconnect assembly could include complete cable assembly or backplane with connectors.
Backplane is without connectors
Modeling in this table means results of these measurements maybe useful to users involved in model creation, model verification or other analysis. Modeling may or may not require some or all "media" to be tested.

Extended distance impedance
Capacitance (SE, DF)
Frequency dependence of dielectric constant
Propagation time - differential signal for each signal pair
Propagation time skew - difference between pairs
+ signal to - signal balance - within the pair (balance degradation)
Attenuation (voltage transfer function) - within the pair
Attenuation skew (difference in voltage transfer function between pairs)
Eye diagrams (signal degradation)
Rise time degradation
Common mode (treat each pair as a single conductor) impedance
Common mode capacitance
Common mode noise
Near end crosstalk
Far end crosstalk
Attenuation to cross talk ratio (ACR)
EMC (CMPT, EMR) shielded versions only

The Level 1 and Level 2 approach described in SFF-8410 will be used. Level 1 is required for performance and has specific acceptable limits defined. Level 2 is diagnostic and has no specific limits defined.

There is some support for including additional swept frequency tests (possibly as level 1 tests) but these have not been defined. The issue of how to construct valid time domain signals from frequency domain measurements is part of this discussion. Also the of the choice of interoperability points significantly interacts with the test results and needs to be considered.

The initial cut at the frequency/time domain testing distribution is listed below:

- Local impedance (time domain)
- Extended distance impedance (frequency domain)
- Capacitance (SE, DF) (frequency domain)
- Frequency dependence of dielectric constant (frequency domain)
- Propagation time - differential signal for each signal pair (time domain and frequency domain – needs more work)
- Propagation time skew - difference between pairs (time domain and frequency domain – need more work)
- + signal to - signal balance - within the pair (balance degradation)
- Attenuation (voltage transfer function) - within the pair (frequency domain)
- Attenuation skew (difference in voltage transfer function between pairs) (frequency domain)
- Eye diagrams (signal degradation)
- Rise time degradation
- Common mode (treat each pair as a single conductor) impedance
- Common mode capacitance
- Common mode noise
- Near end crosstalk (time domain and frequency domain – needs more work)

- Far end crosstalk (time domain and frequency domain – needs more work)
- Attenuation to cross talk ratio (ACR) (frequency domain)
- EMC (CMPT, EMR) shielded versions only (frequency domain)

The following represents the present thinking on the division of tests between the level 1 and level 2 types.

Level 1

- Local impedance
- Extended distance impedance
- Propagation time - within the pair
- A.C. signal degradation - all pairs to clock (Full signal characterization - e.g. Eye diagrams)
- D.C. leakage to ground [impacts receiver bias / d.c. offset]
- A.C. balance degradation within the pair (+ signal to - signal balance /common mode)
- End to end d.c. resistance difference within the pair
- Capacitance (SE, DF)
- Near end crosstalk (for noise induced on wired-or signals)
- Far end crosstalk (for noise induced on wired-or signals)

- EMC (CMPT, EMR) shielded versions only

Level 2

- Signal degradation within the pair (Full signal characterization - e.g. Eye diagrams [note that the full set of signals with respect to the clock is the level 1 requirement – a single signal performance is not adequate (example being different jitter and proptime on different signals)]
- Rise time degradation
- Frequency dependence of dielectric constant
- Attenuation to cross talk ratio (ACR)
- Attenuation (voltage transfer function) - within the pair
- Attenuation skew (difference between voltage transfer function pairs) - pair to pair
- Propagation time skew - pair to pair

Problem areas needing future attention - not classified yet:

- Common mode impedance
- Common mode capacitance
- Common mode noise
- Resonance effects

### 18.1.5 Instrumentation / measurement methods:

- Baluns
- Eye diagram / signal degradation testing (including cross talk noise)
- Filtering schemes for eye pattern generation

These topics are in addition to other issues already identified for media.

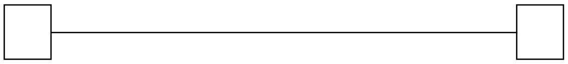
### 18.1.6 Acceptable performance values

All level 1 tests will have specific acceptable values proposed.

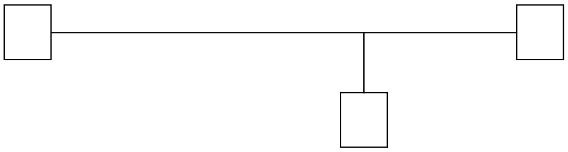
## 19. Starting point for specifying application of tests

The following configurations were agreed to be used for the next steps in developing specifications for the application of the tests.

SIMPLEST POINT TO POINT



SIMPLEST MULTIDROP



☐ UNMATED CONNECTOR

The point to point construction allows inclusion of connectors and transition regions, multiple line cross talk, resonance issues and other issues not previously considered in uniform cable media.

The simplest multidrop construction adds a single connector and greatly increases the number of possible interactions between lines as well as adding a known non-uniformity in addition to the connectors and transitions regions in the point to point construction.

Clearly these simple constructions do not have the desired complexity of some interesting applications. These more complex constructions, such as backplanes will be considered after we complete these initial constructions. [Note: the complexity for these simple constructions is significantly greater than that previously considered.]

### 19.1 Definitions for the document - Barnes

Not addressed at this meeting.

## 20. Architectural definitions

This refers to issues like defining the test points, nomenclature, and the like. It was decided to use the same conventions commonly used for modeling and transmission lines if possible. Larry B to propose a specific syntax for the next meeting.

All measurements will be through a mated connector. This means that the test fixturing specification will be critical since part of the tested interconnect will remain with the test environment and part will be removable with the IUT.

Zane is creating a summary table for all tests defined above and to start the document.

It was agreed that a special filtering function is needed for some tests to account for the filtering that may occur in the receivers. See 00-149r0 for more detail.

## 21. Old business

## 22. New business

### 22.1 Standardization of non uniform media, Greg Vaupotic

### 22.2 Skew measurement and specification methodology, Ham

## 23. Next meetings

Approved schedule:

April 3-4, 2001 9AM to 5 PM 04/03; 9AM to 12PM 04/04 Worcester, MA (Madison)

Requested schedule:

June 12-13, 2001 9AM to 5 PM 06/12; 9AM to 12PM 06/12 Hamden, CT (Amphenol Spectra Strip)

August 14-15, 2001 9AM to 5 PM 08/14; 9AM to 12PM 08/14 Orange Co, CA (TI)

October 23-24, 2001 9AM to 5 PM 10/23; 9AM to 12PM 10/24 Colorado Springs, CO (LSI Logic)

December 11-12, 2001 9AM to 5 PM 12/11; 9AM to 12PM 12/12 Guadalajara, MX (JPM)

## 24. Action Items:

### 24.1 Old action items from previous meetings

Larry Barnes to acquire data from the polished coax probe method for dielectric constant frequency variations.
Status: equipment now in hand, test results now expected before April meeting due to chemical availability

Zane to provide data from the HP slab method for dielectric constant frequency variations
Status: carried over

Bill Ham to post the minutes to the T10 web site
Status: done 01-019r0

Zane to create a summary table for all tests defined above and to start the document.
Status: done

Larry Barnes to look at list of proposed tests and suggest revisions / additions to incorporate possible frequency domain tests and design validation tests and production tests.
Status: done

Larry B to propose a specific syntax for defining the test points, nomenclature, and the like for the next meeting.
Status: overcome by events

Ham to select 2 boards for use in the backplane round robin.
Status: partly done carried over / overcome by events

Bill Ham to extract this section on interoperability points for presentation at the next SCSI plenary meeting and to produce a version suitable for use in the SSM document.
Status: partially done - the SSM part is carried over

Umesh to select 2 boards for use in the backplane round robin 1.

Status: done - one from Molex and one from Seagate

Ham to select 2 boards for use in the backplane round robin 1.
Status: carried over pending permission from the owners of the board designs / overcome by events

Umesh to propose a set of tests to be used including things like test fixtures and specific slots to be measured for backplane round robin 1.
Status: carried over

Umesh to determine if/when the data spewing card could be made available to the industry for use in PIP applications.
Status: carried over

### 24.2 New actions from this meeting

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

Action to Ham to create a modified SD3 for PIP as a standard 00-238r1.
Status: new

Bill Troop to select 1 or 2 boards for use in the backplane round robin 1.
Status: new

Ham to deliver a single 10 slot Compaq backplane (one that is presently shipping) for backplane round robin 1.
Status: new