Accredited Standards Committee*
NCITS, Information Technology

Doc. No.: T11.2/00-152v1
Date: April 03, 2000
Project: FC0 MJS ad hoc
Ref. Doc.:
Reply to: Dennis Petrich
Schelto Van Doorn
Bill Ham

To: Membership of T11.2

From: Dennis Petrich, chair MJS working group
Bill Ham, Secy MJS working group

Subject: Approved minutes of T11.2 FC0 MJS working group on February 14, 17, 2000

Agenda

1. Opening remarks and introductions
2. Attendance and membership
3. Approve agenda
4. Document distribution
5. Review minutes of previous meeting
6. Review old action items
7. Call for patents
8. Discussions/presentations
   - 8.1 Cross talk on Fibre Channel - Dennis Petrich, Wavecrest
   - 8.2 BERT-TIA correlation study - Dennis Petrich, Wavecrest
   - 8.3 Crosstalk vs duplex - Dean Vermeersch, AMP
   - 8.4 Equalizers vs jitter - Dean Vermeersch, AMP
9. MJS meeting strategy - Ham / Petrich
10. Status of MJS-2 sections - Ham
    - 10.1 Creation of the structure of the MJS-2 document - Ham
    - 10.2 MJS-2 section assignment summary
    - 10.3 MJS-2 pilot sections - Ham
    - 10.4 Follow up on golden PLL letter - Dennis Petrich, Wavecrest
11. Review action items
12. Next meetings
13. Adjourn

Results of Meeting

1. Opening remarks and introductions

Dennis Petrich led the meeting. He opened the meeting at 9:00 AM and thanked the host, Skip Jones of QLogic, for hosting the meeting. Bill Ham took these minutes. This meeting was split between Monday, February

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14, 2000 and Thursday, February 17, 2000. These minutes cover both days.

2. Attendance and membership

Attendance at plenary meetings does count toward minimum attendance requirements for T11.2 membership. Working group meetings are open to any person or organization directly and materially affected by T11.2's scope of work but do not count toward minimum attendance for T11.2 membership.

The following people attended the meeting:

Name	Status/Company	Tel

[The attendance is not available for these minutes -- contact Schelto van Doorn for the list.]

3. Approve agenda

Bill Ham moved and Mike Jenkins seconded that the agenda as shown above be approved. The motion passed without objection.

4. Document distribution

This section describes the availability of draft documents that are intended to be published as a result of work by the MJS committee.

Document distribution is now being done over the web. Documents relating to MJS work can be found on the T11 web site (www.t11.org) by going to "documents" and searching on the key words "jitter" and/or "MJS".

The only active document in this working group is the MJS-2 technical report presently at rev 0.0.

A summary of the presently active policy to document distribution is included for reference.

All presentations are posted electronically at the approved ftp within two weeks after the meeting. Format must be an approved electronic file format. While we are still paper based, a paper copy must also be given to the secretary at the working group meeting.

(Presentations are defined as material shown publicly in the Plenary or authorized working group meetings.)

Submission of Documents for T11 Document Numbers:

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A online system is now available to provide document numbers and accept the submission of documents. The system is accessed via the t11 web page at http://www.t11.org. Follow the "docs" link in the left-hand frame, or at the bottom, and fill in a form giving details about the document. In order to complete the form, it will be necessary to enter a password. The password is given out at T11 meetings, or can be obtained from the T11 Chair. Instructions will then be given about uploading the file to the ftp site at ftp.t11.org.

We now use all electronic document distribution.

A T11.2 reflector is operational over the t11 site.

The committee forms its agenda by the following:

1. A call (reminder) for presentations by the chair 3 weeks in advance

2. Those wanting to be on the agenda submit request including:
   title
   presenter
   time required
   abstract

3. Chair creates agenda and posts 2 weeks in advance of the meeting

4. At the meeting it is the chairs's discretion to allow additional presentations

5. Review minutes of previous meeting

The minutes of the last MJS working group were reviewed with some minor editorial changes. Rich Feldman moved and Dave Instone seconded that the minutes as modified be accepted. Motion passed without objection. The amended minutes will be posted to the ftp site under a document number with an "ap" in the document name.

Action item: Ham will get the document number and do the posting.

6. Review old action items

The old action items were reviewed and the status was updated.

7. Call for patents

Below is the formal call for patents which was issued by Dennis at the meeting:

PATENTS

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- *A call is hereby issued for the existence of patents required to implement the results of any & all T11 projects to be disclosed*
  It is necessary for the holders to agree to license those patents in conformance with the ANSI patent policy if the project on which they read is to proceed
  T11.2 is not involved in this process @ all !
- *The contact @ ANSI is the General Counsel, Ms. Amy Marasco -(212)642-4954 or amarasco@ansi.org*
- *Patent policy description @ www.ansi.org/proctbl.html, section 1.2.11*
- *IBM has declared that it has patents which apply to the practice of FC & SBCON. The contact is:*
  Tom Slattery, Program Director, IBM Corporation, North Castle Drive, Armonk, New York 10504
  Tel: (914) 765-4351, Fax: (914) 765-4390, Email: tmslatt@us.ibm.com
  Thanks to Stuart Berman of Vixel for tracking down this new contact

There was no response to this call for patents.

8. Discussions/presentations

8.1 Cross talk on Fibre Channel - Dennis Petrich, Wavecrest

This presentation was a continuation of the work presented at the last meeting and has been posted as document 00-064v0. Using more refined test configurations he showed that excellent ability to extract the gaussian and bounded uncorrelated jitter when using actual FC-like signals.

One requirement to use this jitter component separation algorithm is the ability to separately distinguish between rising transitions between states and falling transitions between states. This capability to distinguish between transitions is not present in scope based measurements using the eye diagram methods (it is present when using the repeated pattern scope methods). The BERT scheme, on the other hand, does use the rising and falling transition relationship for individual bits (a “1” is always preceded by a rising transition and a “0” is always preceded by a falling transition) and has essentially the same information content.

The discussion provoked by this presentation produced an important refinement in the categorization of jitter. A basic division between uncorrelated and correlated met with general agreement. The correlation with what prompted significant discussion. Clearly the correlation with the transmitted data pattern is important but there are other features of the transmitted signal that are also important contributors to the measured jitter. An example of a feature of the transmitted signal that does not depend on the data pattern is the slew rate. This slew rate is a primary parameter in determining how much jitter the cross talk noise will produce.

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This subject of categorization was left without further resolution. Bill Ham suggested that the correlation could be between the jitter and the transmitted signal (or not).

8.2 BERT-TIA correlation study - Dennis Petrich, Wavecrest

This presentation is 00-065v0.

This presentation focused on comparing a pure serial stream (datacom mode) TIA, BERT (using a separate clock), and an “eye diagram” mode with TIA. The conclusions are basically that schemes that use an independent clock are prone to serious errors because of the fragility of the clock path throughout the entire system path. If the clock is pristine, excellent correlation is found with the TIA datacom approach.

If the clock is not pristine then very serious errors may be present in the BERT and eye diagram approaches.

Another result was that reflections and other details within the test setup can causes serious correlation problems. Specifically, the termination provided by various instruments may be quite different even when specified to be nominally identical. In other words, a 50 ohm termination may not adequately specify the a.c. properties of the path behind the instrument connector. Cable assemblies also may cause serious issues due to difference in impedance profiles within the cable assembly.

Note that TIA measurements do not eliminate the need for pristine test setups. For example if the TIA has a different input impedance than a Bert in an otherwise identical test environment then correlation may not be optimal.

8.3 Crosstalk vs duplex - Dean Vermeersch, AMP

This document is 00-060v0. Dean presented data on duplex copper cable assemblies that showed the effects of the second source on jitter. Some of this data indicates that the specifications for copper receivers are significantly too loose. See SFF 8410 r16 for the details of the second source measurement.

8.4 Equalizers vs jitter - Dean Vermeersch, AMP

00-062v0 Dean showed the very considerable improvements that can be achieved in duplex copper cable assemblies by using passive equalization. Lengths up to 40 meters with 22 AWG quad constructions were shown that meet the present FC full speed specification. Although specific data was not presented Dean claimed that at least 50 meters is possible for full speed FC if the receive mask were reduced to 200 mV pk to pk from its present 400 mV.

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9. MJS meeting strategy - Ham / Petrich

Due to unacceptable progress in producing the next revision of the jitter document (little additional material submitted and a general lack of progress) the next MJS-2 meeting will be focused on editing the MJS-2 document only. The basic administrative operations will be conducted but only material submitted for inclusion in the MJS-2 document will be discussed.

It is expected that the normal meeting style will resume in June if adequate progress is made in April.

10. Status of MJS-2 sections - Ham

10.1 Creation of the structure of the MJS-2 document - Ham

A complete review of the existing document and structure of MJS-2 was conducted. The most important activities focused on clear assignment of responsibility for the various sections of the document.

Following is the presently agreed organization of the MJS-2 document with names of those responsible for specific sections:

Sections 1 thru 5 - Ham

1. Introduction
1.1. Document scope and purpose
1.2. Document organization
2. T11.2 Membership
3. References
4. Definitions and conventions
4.1. Conventions
4.2. Acronyms
4.3. Definitions
5. Scope
5.1. Motivation and goals
5.2. Authority
6. Jitter overview
6.1. FC-0 and MJS (-1) interface overview - Ham
6.2. Fibre channel storage implementation - copy if possible
6.3. Jitter contribution elements - Wavecrest Mike Li
6.3.1. Reference times - TBD
6.3.2. Signal amplitude effects - TBD
6.3.3. Generalized jitter concepts - TBD
6.3.4. Deterministic contributors (copy)

6.3.5. Random contributors (copy)
6.4. Improved Bit Error Rate vs. Jitter Model (copy from MJS-1) - Tom Lindsay if mods needed
6.4.1. Description of Mathematical Model
6.4.2. Random Jitter
6.4.3. Addition of Deterministic Jitter

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6.5. Equalization - Mike Jenkins
6.5.1. Filtering
6.5.2. Pre-emphasis
6.5.3. Adaptive transmitters
6.5.4. Adaptive receivers
6.5.5. Distributed
6.6. Separation of jitter components - Tom Lindsay
6.6.1. Need to separate components
6.6.2. General considerations
6.6.3. Mathematical basis
6.6.4. Accuracy and precision
6.6.5. Tools
6.7. Jitter accumulation and transfer- Tom Lindsay
6.8. Data rate considerations
6.9. Effects of parallel paths - skew, cross talk, imbalance
6.10. Pattern dependent random jitter - Mike Jenkins
6.11. Jitter methodologies (copy from MJS if relevant)
6.11.1. Current practice and specifications
6.11.2. Jitter measurement definitions
7. Jitter test methodologies - Ham
7.1. Goals - Ham
7.2. Level 1 and level 2 tests - Ham
7.3. System considerations - TBD
7.4. Component considerations - TBD
7.5. Instrumentation considerations - TBD
7.5.1. LESB
7.5.2. BER
7.5.3. FC compliant
7.5.4. Non-FC compliant
7.5.5. Built in test features
7.6. Test fixture considerations - Ham
7.7. System / environmental noise considerations
7.8. Reference standards / calibration considerations
7.9. Data output format considerations
7.10. Jitter output test methodologies (copy from MJS)
(need effect of high pass filter discussion)
7.10. Jitter tolerance test methodologies (copy from MJS)
(need reference to jitter output section for tolerance test conditions)
8. Requirements for specific tests
[Only one example is shown for simplicity – need to generate a comprehensive list – this will be a very long section]
8.1. Optical Gamma T output (started already)
8.1.1. FC device (requires full protocol signals to work) - Rich Feldman (Bert and scope methods only)
8.1.1.1. Overview
8.1.1.2. Test Fixtures
8.1.1.3. Instrumentation
8.1.1.4. Calibration
8.1.1.5. Test execution
8.1.1.6. Data output formats
8.1.1.7. Acceptable values
8.1.2. FC protocol neutral component - TBD
8.1.2.1. Overview
8.1.2.2. Test Fixtures
8.1.2.3. Instrumentation
8.1.2.4. Calibration

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8.1.2.5. Test execution
8.1.2.6. Data output formats
8.1.2.7. Acceptable values
8.2. Copper Gamma R output
8.2.1. FC device transmitter (requires full protocol signals to work) - TBD
8.2.1.1. Overview
8.2.1.2. Test Fixtures
8.2.1.3. Instrumentation
8.2.1.4. Calibration
8.2.1.5. Test execution
8.2.1.6. Data output formats
8.2.1.7. Acceptable values
8.2.2. FC protocol neutral component - TBD
8.2.2.1. Overview
8.2.2.2. Test Fixtures
8.2.2.3. Instrumentation
8.2.2.4. Calibration
8.2.2.5. Test execution
8.2.2.6. Data output formats
8.2.2.7. Acceptable values
8.3. Copper Beta R tolerance (already started)
8.3.1. FC device (requires full protocol signals to work) - Allen Kramer
8.3.1.1. Overview
8.3.1.2. Test Fixtures
8.3.1.3. Instrumentation
8.3.1.4. Calibration
8.3.1.5. Text execution
8.3.1.6. Data output formats
8.3.1.7. Acceptable values
8.4. Optical Gamma R tolerance - Tom Lindsay
8.4.1. FC device (requires full protocol signals to work)
8.4.1.1. Overview
8.4.1.2. Test Fixtures
8.4.1.3. Instrumentation
8.4.1.4. Calibration
8.4.1.5. Text execution
8.4.1.6. Data output formats
8.4.1.7. Acceptable values
8.4.2. FC protocol neutral component
8.4.2.1. Overview
8.4.2.2. Test Fixtures
8.4.2.3. Instrumentation
8.4.2.4. Calibration
8.4.2.5. Test execution
8.4.2.6. Data output formats
8.4.2.7. Acceptable values
Further sections will be added to section 8 for all interoperability points and all versions - these sections will re-use major parts of the above sections
9. 10 Examples
9.1. Jitter budget allocations - TBD
9.2. Jitter tolerance specification - TBD
9.3. Revised jitter output allocation tables - TBD
9.4. Separation of jitter components - Dennis Petrich
9.5. Jitter accumulation (+ or-) - Mike Jenkins
9.6. Amplitude to phase conversion - TBD

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9.7. Proper use of eye diagrams and masks - TBD

Annex A - Implementation strategies - TBD

A.1 Repeaters
A.2 Latency
A.3 Bandwidth

[These following annexes are extracted from MJS-1 for reference – need to consider what we need for MJS-2.]

Annex B
Improved Test Bit Sequences
B.1 Test bit sequence characteristics
B.1.1 Low Frequency Pattern
B.1.2 Low transition density patterns
B.1.2.1 Half-rate square pattern
B.1.2.2 Quarter-rate square pattern
B.1.2.3 Ten contiguous runs of 3
B.1.3 Composite patterns
B.2 Compliant jitter test bit sequences
B.2.1 Random test bit sequence
B.2.1.1 Background - fibre channel frame
B.2.1.2 Original RPAT
B.2.1.3 Compliant RPAT (CRPAT)
B.2.2 Compliant Receive Jitter Test Bit Sequence
B.2.2.1 Receive Jitter Tolerance Pattern
B.2.2.2 Compliant Receive Jitter Tolerance Pattern
B.2.3 Supply Noise Test Bit Sequences
B.2.3.1 Supply Noise SPAT
B.2.3.2 Supply Noise CSPAT
B.3 System Jitter Testing Issues
Annex C
Jitter Tolerance Test Methodologies
C.1 Calibration of a Signal Source using the BERT Scan Technique
C.2 Sinusoidal Jitter Modulation
C.3 Direct Time Synthesis
Annex D
Jitter Output Test Methodologies
D.1 Jitter Output Test Methodologies
D.2 Time Domain Measurement - Scope and BERT Scan
D.2.1 Overview
D.2.2 Golden PLL
D.2.3 Time Domain Scope Measurement
D.2.4 BERT Scan
D.3 Time Interval Analysis
D.3.1 Introduction
D.3.2 "Clock-less" Jitter Measurement
D.3.3 TIA Data Reduction Procedure
D.3.4 Total Jitter Calculation
D.3.5 Power Density Spectrum of Jitter
D.3.6 Data Dependent (ISI) Jitter Measurement
D.3.7 Jitter Measurements with a "Pattern Marker and known pattern"
D.3.8 Jitter Measurement Using a Sampling Oscilloscope (DDJ and PWD)
D.4 Frequency Domain Measurement (Spectrum Analyzer)

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Annex E
Practical Measurements
E.1 Introduction
E.2 Basic architecture
E.3 Instrumentation interface adapters
E.3.1 Balanced copper
E.3.1.1 Source and sink adapters for balanced copper variants
E.3.1.1.1 Balanced-unbalanced
E.3.1.1.2 Balanced - balanced (alternative 1)
E.3.1.1.3 Balanced - balanced (alternative 2)
E.3.1.2 Tap adapters for balanced copper variants
E.3.1.2.1 Balanced-balanced (alternative 1)
E.3.1.2.2 Balanced - balanced (alternative 2)
E.3.1.2.3 Balanced-Unbalanced
E.3.1.3 Extracting a balanced trigger signal
E.3.2 Unbalanced copper
E.3.2.1 Source and sink adapters for unbalanced copper variants (alternative 1)
E.3.2.2 Source and sink adapters for unbalanced copper variants (alternative 2)
E.3.2.3 Tap adapters for unbalanced copper variants (alternative 1)
E.3.2.4 Tap adapters for unbalanced copper variants (alternative 2)
E.3.3 Optical
E.3.3.1 Source interface adapters
E.3.3.2 Sink interface adapter
E.3.3.3 Optical tap
E.3.4 Specific tests
E.3.5 Description of baluns
E.3.5.1 Balun requirements
E.3.5.1.1 Core and transmission-line requirements
E.3.5.2 Specific wound core construction details
E.3.5.2.1 Alternative 1 - wound toroid construction
E.3.5.2.2 Alternative 2 - wound toroid construction
E.3.5.2.3 Alternative 3 - wound bead construction
E.3.5.3 Connection of wound cores into baluns
E.3.5.4 Other source/sink adapter components
Annex F
Practical Examples for Jitter Compliance
F.1 Introduction
F.2 Elements contributing to jitter
F.3 Hubs
F.4 Retiming hubs
F.5 Repeating hubs
Annex G
Choosing the Corner Frequency: fc / 1 667

Action item: Ham to create and post a rev 0 draft MJS-2 document based on the existing MJS-1 document and the discussions reported above in this meeting.

10.2 MJS-2 section assignment summary

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The following people have signed up for specific sections:

Allen Kramer, Seagate
Tom Lindsay, Vixel
Bill Ham, Compaq
Mike Li, Wavecrest
Mike Jenkins, LSI
Rich Feldman, Gadzoox
Dennis Petrich, Wavecrest
Brian Herzing, Methode

The following people have indicated that they would be willing to contribute to specific sections of the document but do not have specific sections assigned yet:

Douglas Nast, Boeing
Ron Miller, Brocade
Ed Grivna, Cypress Semiconductor

Summary of MJS-2 sections and owners with percentage completion ():

Sections 1 thru 6.2 - Ham (20%)
[6.0 is the overview section]
6.3. Jitter contribution elements - Wavecrest Mike Li (0%)
6.4. Improved Bit Error Rate vs. Jitter Model (copy from MJS-1) - Tom Lindsay if mods needed (95%)
6.5. Equalization - Mike Jenkins (10%)
6.6. Decomposition of jitter components from total jitter - Tom Lindsay (50%)
6.7. Jitter accumulation and transfer- Tom Lindsay (50%)
6.8. Budget allocation for components - Tom Lindsay (0%)
6.9. Data rate considerations
6.10. Effects of parallel paths - skew, cross talk, imbalance - TBD
6.11. Pattern dependent random jitter - Mike Jenkins (0%)
7.1. Goals - Ham (10%)
7.2. Level 1 and level 2 tests - Ham (80%)
7.6. Test fixture considerations - Ham (50%)
7.7. System / environmental noise considerations
7.8. Reference standards / calibration considerations - Dennis Petrich (0%)
7.9. Data output format considerations

7.10. Jitter tolerance test methodologies (copy from MJS)
7.11. Jitter output test methodologies (copy from MJS)
8.1.1. Optical Gamma T FC device (requires full protocol signals to work) - Rich Feldman (Bert and scope methods only) (20%)
8.1.1. Optical Gamma T FC device (requires full protocol signals to work) - Dennis Petrich (TIA methods) (0%)
8.1.2. Optical Gamma T FC protocol neutral component - Brian Herzing (0%)
8.2. Copper Gamma T output - Robert Mejia (5%)
8.3.1. Copper Beta R tolerance FC device (requires full protocol signals to work) - Allen Kramer (20%)
8.4. Delta T output - Tom Lindsay (0%)

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8.4.2.1. 8.4. Delta R output - Tom Lindsay (0%)
9. Examples
9.1. Jitter budget allocations for components - TBD
9.2. Jitter tolerance specification - TBD
9.3. Revised jitter output allocation tables - TBD
9.4. Separation of jitter components - Mike Li (20%)
9.5. Jitter accumulation (+ or -) - Mike Jenkins (0%)
9.6. Amplitude to phase conversion - TBD
9.7. Proper use of eye diagrams and masks - TBD

Annex assignments are still TBD.

Action item: Ham to post the section assignments to the T11.2 reflector and to the web site as a separate document.

10.3 MJS-2 pilot sections - Ham

This item was not specifically worked on. The time allocated on Thursday was used for development of the document organization. While these pilot sections continue to be valuable, the optical gamma T is being worked by Rich Feldman and the copper beta R is being worked by Allen Kramer.

10.4 Follow up on golden PLL letter - Dennis Petrich, Wavecrest

Dennis will review the responses from the previous letter recipients to determine the status and prognosis for the availability of real golden PLL's.

11. Review action items

Old action items from past meetings with status as of this meeting shown:

1. Dennis P. to compare the Wavecrest algorithm to his BERT scan results.
   Status: done

2. Mike Jenkins to test Wavecrest's application against known theoretical data.
   Status: overcome by events – deemed not practical

3. Dennis Petrich to add definition of Gaussian noise source in terms of amplitude to phase conversion
   Status: carried over

4. Ham will get the document number for the minutes and do the posting to the web site

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Status: done 99-785v0

5. Dennis to conduct a review of the replies to the letter to suppliers requesting development of golden PLL's
   Status: carried over

6. Dennis to create a proposal for a technique for generating an arming signal from a serial bit stream and the software to deal with the random insertion or deletion of fill words.
   Status: done but not yet uploaded

7. Mike Dudek to measure the DJ and RJ down an operating link using the Wavecrest routine to validate that the components add up as expected.
   Status: carried over

8. Ham to create and post a rev 0 draft MJS-2 document based on the existing MJS-1 document and the discussions reported above in this meeting.
   Status: carried over

9. Action item: Ham to post the MJS-2 section assignments to the T11.2 reflector and to the web site as a separate document.
   Status: done 99-789v0

New action items from this meeting:

1. Ham will get the document number for the minutes and do the posting to the web site
   Status: new

12. Next meetings

The next working group meeting will be requested for Monday April 03, 2000, in San Diego, CA from 9AM to 5PM. A second meeting on Thursday AM from 9:00 to 12:30 will be focused on developing the details of the test methods for MJS-2.

No interim meetings are presently planned.

13. Adjourn

The meeting adjourned at 12:00 on Thursday.

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