Technical Reference

Tektronix

RT-Eye® Serial Data Compliance and Analysis Standards Support Library Methods of Implementation (MOI) 071-2387-00

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1 Introduction to the RT-Eye Standards Support Library

This document provides the procedures for making high speed serial standard measurements with Tektronix TDS/CSA7000, DSA/DPO70000 and TDS6000 series real time oscilloscopes and probing solutions. The Serial Analysis module in RT-Eye provides clock recovery, eye diagram, amplitude, and jitter measurements found in most high speed serial data specifications. The Serial Analysis module also supports waveform mask testing and measurement limit testing with Pass/Fail indication. Pass/Fail criteria for the signal under test is called out in the electrical specifications of industry standards.

The Standards Support Library consists of a library of setup folders under the File > Recall selection from the RT-Eye menu. The library of setup files provides testing for the following standards:

- DisplayPort
- FibreChannel
- Ethernet (XAUI and 10GBaseCX4)
- InfiniBand (DDR and QDR)
- OBSAI (Open Base Station Architecture Initiative)
- SAS (Serial Attached SCSI)
- Serial RapidIO

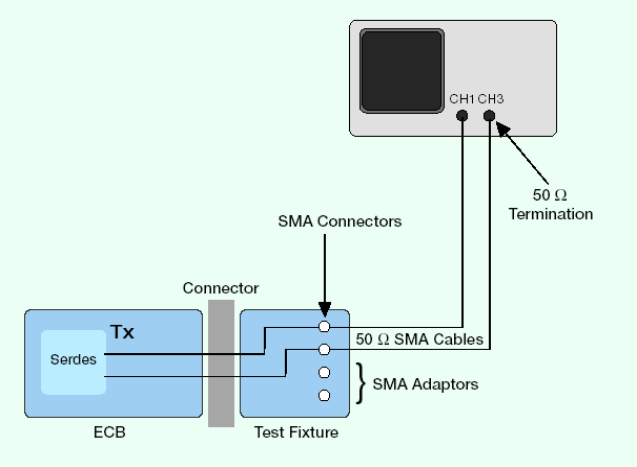
The setup files are consistent with the ‘compliance points’ called out in the standards. The proper waveform mask (.msk) and measurement limits (.lim) file are recalled as part of the setup file. Once the file is recalled, Pass/Fail testing on the signal under test can be completed by simply pressing Autoset and Run from the RT-Eye menu.

2 Connecting to the Device Under Test (DUT)

There are four fundamental probing techniques to perform standards-based ‘compliance’ measurements using the Standards Support Library. These probing techniques are described below. Probe configurations A and C represent the **Probe Type: Single Ended** in the RT-Eye Measurement Select Menu. This is the default configuration of the setup files in the library. The probe type can be changed to **Probe Type: Differential** if a differential probing solution (Probe configuration B or D) is used.

2.1 SMA Connection to the DUT

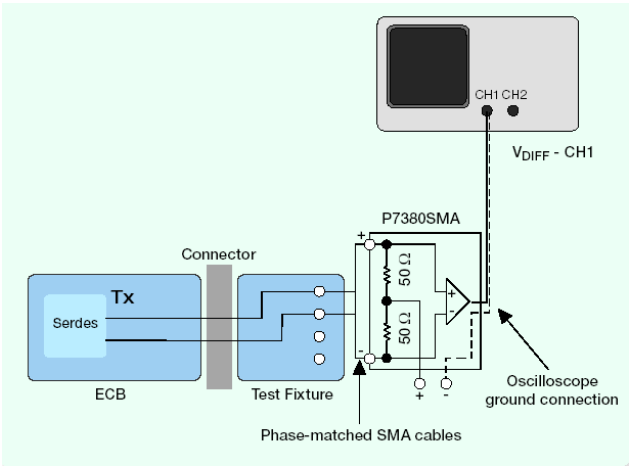
A. Two TCA-SMA inputs using SMA cables (Ch1) and (Ch3)
The differential signal is created by the RT-Eye SW from the math waveform Ch1-Ch3. The Common mode AC measurement is also available in this configuration from the common mode waveform (Ch1+Ch3)/2. This probing technique requires breaking the link and terminating into the 50 Ω/side termination into the oscilloscope. Ch-Ch deskew is required using this technique because two channels are used.



Probe Configuration A

SMA Psuedo-differential

B. One P7350SMA differential active probe (Ch1)
The differential signal is measured across the termination resistors inside the P7350SMA probe. This probing technique requires breaking the link. Matched cables are provided with the P7350 probe to avoid introducing de-skew into the system. Only one channel of the oscilloscope is used.



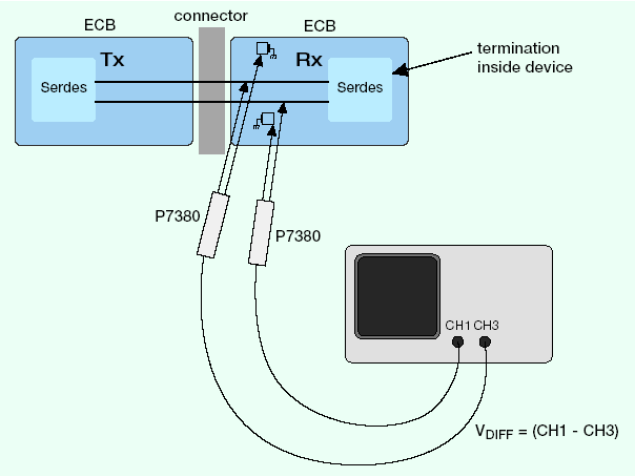
Probe Configuration B

SMA Input Differential Probe

2.2 ECB probe connection to the DUT

C. Two single ended active probes (Ch1) and (Ch3)

The differential signal is created by the RT-Eye SW from the math waveform Ch1-Ch3. The Common mode AC measurement is also available in this configuration from the common mode waveform (Ch1+Ch3)/2. This probing technique can be used for either a live link that is transmitting data, or a link terminated into a “dummy load”. In both cases, the single ended signals should be probed as close as possible to the termination resistors on both sides with the shortest ground connection possible. Ch-Ch deskew is required using this technique because two channels are used.

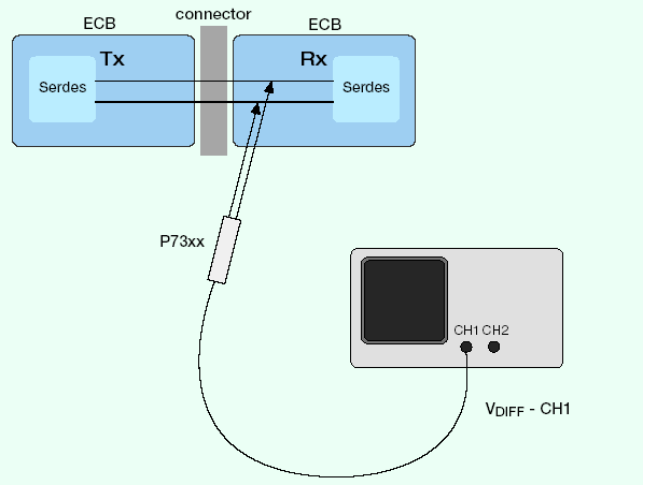


Probe Configuration C

Two Single Ended Active Probes

D. One Differential probe

The differential signal is measured directly across the termination resistors. This probing technique can be used for either a live link that is transmitting data, or a link terminated into a “dummy load.” In both cases, the signals should be probed as close as possible to the termination resistors. A single channel of the oscilloscope is used, so de-skew is not necessary. Two differential probes can be used to create the probing configuration shown in configuration “C” above.



Probe Configuration D

One Differential Active Probe

3 Configuring a DUT for Compliance Measurements

To perform measurements to an industry standard, the device under test must be placed in a state where the device is transmitting the specification compliant test pattern. Mechanisms for this are standard specific. Refer to details in the specifications on which patterns are to be used. To ensure that a measurement can be displayed with multiple patterns, the Standards Support Library setup files use the RT-Eye 'Arbitrary Pattern' method. This can be changed to the 'Repeating Pattern' method if desired by the user. To insure accurate jitter measurements, it's recommended that 100 repeats of the pattern under test be captured in the acquisition. The record length may need to be increased to capture enough repeats for accurate and repeatable measurements regardless of which jitter method is used.

4 Taking Measurements

4.1 Initial Oscilloscope Setup

After connecting the DUT by following the proper probing configuration for the test, click DEFAULT SETUP.

4.2 Running the RT-Eye Software

On non-B or non-C model oscilloscopes (Example: TDS6604), go to **File** > **Run Application** > **RT-Eye Serial Compliance and Analysis**. For B and C models (Example: TDS7704B, TDS6154C), go to **App** > **RT-Eye Serial Compliance and Analysis**. On DPO/DSA70000 series, go to **Analysis > RT- Eye Serial Compliance and Analysis**. When the RT-Eye Wizard dialog appears, select Cancel. The RT-Eye menu will appear.

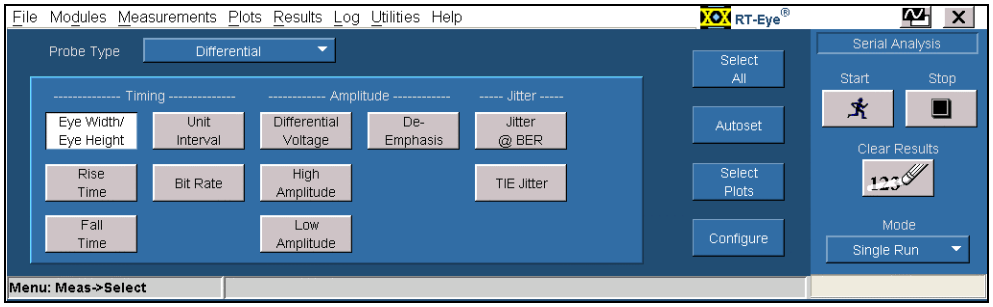


Figure 1 – Default menu of the RT-Eye software

4.3 Selecting a Setup File from the Library

From the RT-Eye default menu, select File > Recall to view the Standards Support Library folders. Select the desired Standard.

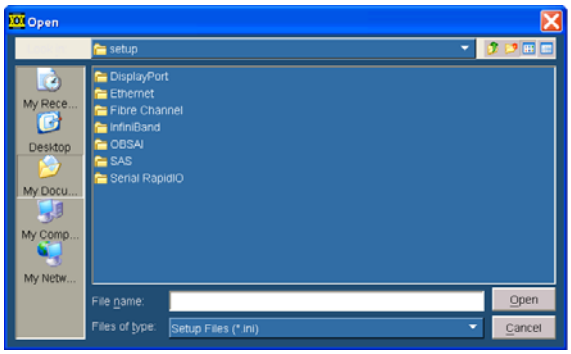


Figure 2 – Standards Support Library Folders

4.4 Selecting a Compliance Test Point from the Library

From the selected folder, select the desired Compliance Test Point. In this example, InfiniBand DDR (Dual Data Rate) TP6 is selected.

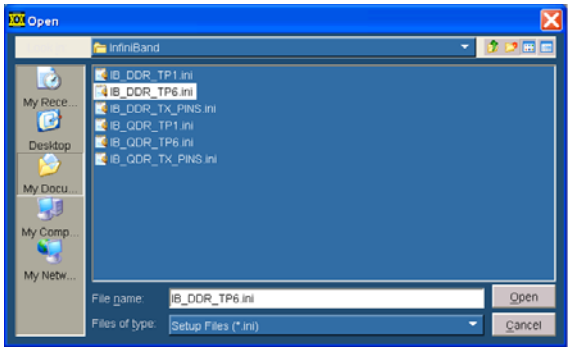


Figure 3 – Compliance Test Point Selection

4.5 Configuring the Probe Type

If Ch1 and Ch3 are the desired source waveforms, this step can be skipped. If the signal being acquired is a Differential signal or a pseudo-differential Math (for example, Math1 = Ch1 – Ch3), change the Probe Type to Differential and then select the appropriate source.

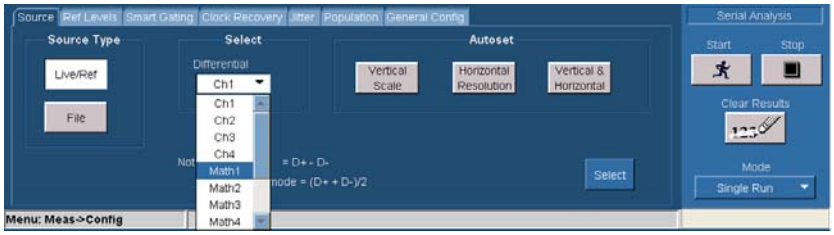


Figure 4 – Selecting Math as a Source of the Measurement

4.6 Selecting Autoset

Press **Autoset** from the RT-Eye Measurement Select Menu. The Horizontal Resolution will be set to full sample rate, and the Vertical Scale will be set to optimize the signal for an accurate measurement.

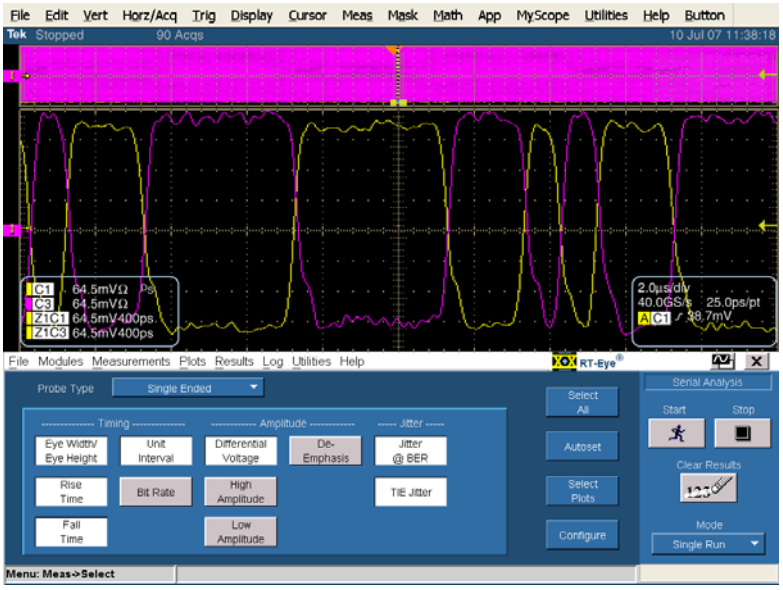


Figure 5 – Oscilloscope settings after Autoset is pressed

4.7 Selecting Start and Viewing Test Results

Select **Start** from the RT-Eye Sequence Control menu. Once the measurements have completed, select **Limits Summary** from the Result Summary View drop-down menu.

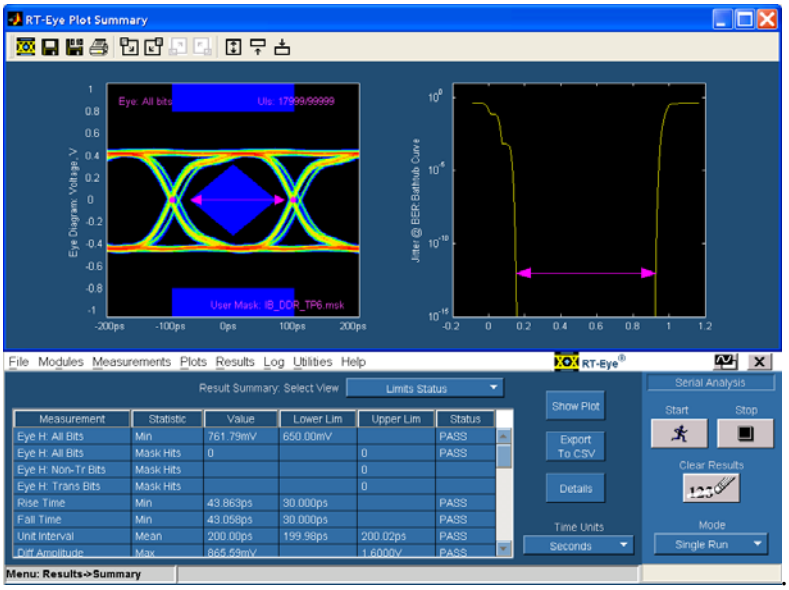


Figure 6a – Results of Analysis with the plots

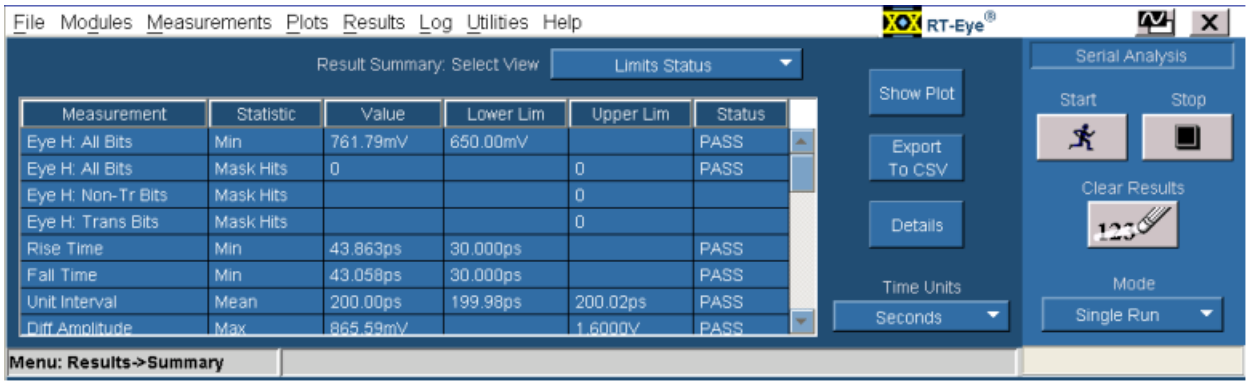


Figure 6b – Results of Analysis with Pass/Fail Indication

5 Creating, Saving, and Sharing Reports

To create a compliance report, select **Utilities** > **Reports**. The Report Generator utility can create a complete report of the test. The report can be saved as a .rpt file for later viewing with the report generator utility. The report can also be saved as a .rtf file for viewing from MS Word. Another convenient way to share reports with your work group is to install a PDF Distiller onto the oscilloscope and print the report to a PDF.

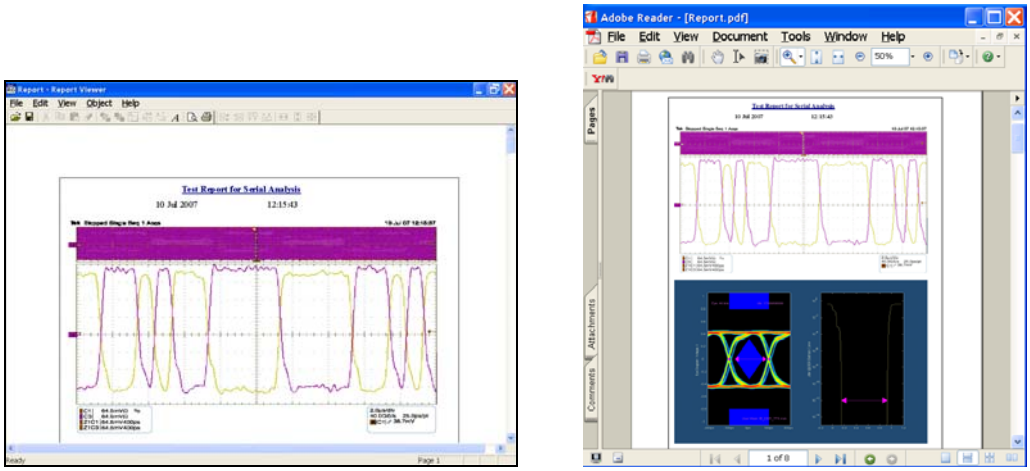


Figure 7 – Report Formats .rpt and .pdf

6 Supported Measurements by Standard

The following sections show the measurements supported by the RT-Eye Standards Support Library. These are listed in table format and intended as an easy cross-reference from what is written in the specification and what the RT-Eye Serial Analysis measurements support. Note that not all measurements called out in the supported standards are supported by RT-Eye. For example, the DisplayPort definition of Rise/Fall time and Differential Skew are different than these same measurements offered in the RT-Eye Serial Analysis Module. Thus, only the measurements supported directly by RT-Eye are selected in the DisplayPort library setup file. More complete testing is left to other methods of implementation documents.

6.1 DisplayPort

Table 1 – DisplayPort Compliance Test Points

Derived from Displag port CTS draft 11 version document				
Displag port	**RT-Eye Measurement**	**Reduced Bit Rate (RBR)**	**High Bit rate (HBR)**	
Nominal Bit Rate	Bit Rate	1.620	2.700	Gb/s
Unit Interval	Unit Interval	617.2840	370.3704	ps
Frequency accuracy	Bit Rate Limits	300	300	PPM
Golden PLL Frequency	2nd Order PLL with damping factor **1.43** Loop BW	20.00	20.00	MHz

Section 3 Displag port Source Compliance tests				
Displag Port specification version 1.1	**RT-Eye Measurement**	**Reduced Bit Rate (RBR)**	**High Bit rate (HBR)**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	616.92	369.39	ps
		0.78	0.64	UI
Total Jitter at 10-9 BER	Jitter@BER; TJ	0.36	0.98	ps
		0.22	0.36	UI
Non ISI Jitter		98.7654321	96.2962963	ps
		0.16	0.26	UI
Intra lane Skew		<= 30		ps
Inter lane Skew test		<= 2		UI
		min	max	
Pre-Emphasis	3.5dB	1.20	1.8	
	6dB	1.60	2.4	
	9.5dB	2.40	3.6	
Non Pre Emphasis Level Verification		min	max	
	400mV	0.34	0.46	V
	600mV	0.51	0.68	V
	800mV	0.69	0.92	V
	1200mV	1.02	1.38	V
A2	Mask Seg 1 and 3			
	400mV	0.46		V
	600mV	0.68		V
	800mV	0.92		V
	1200mV	1.38		V
		RBR	**HBR**	
A1	**400mV 0dB Mask Seg2**	63.6	39.6	mV
	400mV 3.5dB Mask Seg2	95.09	59.24	mV
	400mV 6dB Mask Seg2	126.89	79	mV
	400mV 9.5dB Mask Seg2	189.84	118.2	mV
A1	**600mV 0dB Mask Seg2**	95.4	59.4	mV
	600mV 3.5dB Mask Seg2	142.64	88.86	mV
	600mV 6dB Mask Seg2	190.43	118.51	mV
	600mV 9.5dB Mask Seg2	284.76	177.3	mV
A1	**800mV 0dB Mask Seg2**	127.2	79.2	mV
	800mV 3.5dB Mask Seg2	190.2	118.48	mV
	800mV 6dB Mask Seg2	253.91	158.02	mV
	800mV 9.5dB Mask Seg2	379.69	236.41	mV
A1	**1200mV 0dB Mask Seg2**	190.8	118.8	mV
	1200mV 3.5dB Mask Seg2	285.28	177.72	mV
	1200mV 6dB Mask Seg2	380.87	237.03	mV
	1200mV 9.5dB Mask Seg2	569.53	354.61	mV

Table 1 – DisplayPort Compliance Test Points (Contd.)

X1 (relative to 0.5UI)	Mask Seg2	245.00	127.00	ps
		0.102	0.159	UI
X2 (relative to 0.5UI)	Mask Seg2	0.00	0.00	ps
		-0.110	-0.100	UI
2*A1(Min Eye height)	**400mV 0dB Mask Seg2**	127.2	79.2	mV
2*A1(Min Eye height)	**400mV 3.5dB Mask Seg2**	190.18	118.48	mV
2*A1(Min Eye height)	**400mV 6dB Mask Seg2**	253.78	158	mV
2*A1(Min Eye height)	**400mV 9.5dB Mask Seg2**	379.68	236.4	mV
2*A1(Min Eye height)	**600mV 0dB Mask Seg2**	190.8	118.8	mV
2*A1(Min Eye height)	**600mV 3.5dB Mask Seg2**	285.28	177.72	mV
2*A1(Min Eye height)	**600mV 6dB Mask Seg2**	380.86	237.02	mV
2*A1(Min Eye height)	**600mV 9.5dB Mask Seg2**	569.52	354.6	mV
2*A1(Min Eye height)	**800mV 0dB Mask Seg2**	254.4	158.4	mV
2*A1(Min Eye height)	**800mV 3.5dB Mask Seg2**	380.4	236.96	mV
2*A1(Min Eye height)	**800mV 6dB Mask Seg2**	507.82	316.04	mV
2*A1(Min Eye height)	**800mV 9.5dB Mask Seg2**	759.38	472.82	mV
2*A1(Min Eye height)	**1200mV 0dB Mask Seg2**	381.6	237.6	mV
2*A1(Min Eye height)	**1200mV 3.5dB Mask Seg2**	570.56	355.44	mV
2*A1(Min Eye height)	**1200mV 6dB Mask Seg2**	761.74	474.06	mV
2*A1(Min Eye height)	**1200mV 9.5dB Mask Seg2**	1139.06	709.22	mV
2*X1	Min Eye Width	490.00	254.00	ps
		0.20	0.32	UI
Diff Rise/Fall Time 20-80%	Max Rise/Fall Time	160		ps
Diff Rise/Fall Time 20-80%	Min Rise/Fall Time	50		ps
SE Rise time mismatch		>/= 15% of SE rise time		
SE Fall time mismatch		</= 15% of SE fall time		
Overshoot		</= 25% of Differential swing		
Undershoot		</= 25% of Differential swing		
AC Common Mode Noise		</= 20mV rms		
SSC frequency	min	30		kHz
	max	33		kHz
SSC modulation deviation	min	-5000		ppm
	max	0		ppm
dF/dt		</= 1250ppm/usec		
These tests can be done using RT-Eye				
These tests can be done manually using JIT3				

6.2 Fibre Channel

Table 2 – Fibre Channel 'Beta' Test Points

Derived from FC-PI4 Rev 6.01- February 27th, 2007 - Chapter 9							
FibreChannel Specification	**RT-Eye Measurement**	**100-SE-EL-S 100-DF-EL-S***	**200-SE-EL-S 200-DF-EL-S***	**400-DF-EL-S**	**800-DF-EL-S**	**800-DF-EA-S**	
Nominal Bit Rate	Bit Rate	1.0625	2.125	4.250	8.500	8.500	Gb/s
Unit Interval	Unit Interval	941.1765	470.5882	235.2941	117.6471	117.6471	ps
Bit Rate Tolerance	Bit Rate Limits	100	100	100	100	100	PPM
Golden PLL Frequency	1st Order PLL Loop BW	0.64	1.27	2.55	5.10	5.10	MHz

Beta-Tx Test Point							
FibreChannel Specification	**RT-Eye Measurement**	**100-SE-EL-S 100-DF-EL-S***	**200-SE-EL-S 200-DF-EL-S***	**400-DF-EL-S**	**800-DF-EL-S**	**800-DF-EA-S**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	724.71	315.29	112.94	56.47	NA	ps
		0.77	0.67	0.48	0.48	NA	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	216.47	155.29	122.35	61.18	NA	ps
		0.23	0.33	0.52	0.52	NA	UI
Deterministic Jitter	Jitter@BER; DJ	103.53	94.12	77.65	38.82	NA	ps
		0.11	0.20	0.33	0.33	NA	UI
B	Mask Seg1, Seg3	1000	1000	800	???	???	mV
A	Mask Seg2	300	300	155	???	???	mV
X1 (relative to 0.5UI)	Mask Seg2	-362.35	-157.65	-56.47	???	???	ps
		-0.39	-0.34	-0.24	???	???	UI
X2 (relative to 0.5UI)	Mask Seg2	-183.53	-68.24	0.00	???	???	ps
		-0.20	-0.15	0.00	???	???	UI
2*A	Min Eye Height	600	600	310	???	???	mV
2*X1	Min Eye Width	724.71	315.29	112.94	???	???	ps
		0.77	0.67	0.48	???	???	UI
2*B	Differential Amplitude	2000	2000	1600	???	???	mV
Rise/Fall Time 20-80%	Max Rise/Fall Time	385.00	192.00	NA	NA	NA	ps
Rise/Fall Time 20-80%	Min Rise/Fall Time	100	75	60	30	NA	ps
Skew	Differential Skew*	25	15	NA	NA	???	ps
Common Mode Voltage, RMS	AC CM Voltage	NA	NA	15	15	???	mV

Beta-Rx Test Point							
FibreChannel Specification	**RT-Eye Measurement**	**100-SE-EL-S 100-DF-EL-S***	**200-SE-EL-S 200-DF-EL-S***	**400-DF-EL-S**	**800-DF-EL-S**	**800-DF-EA-S**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	395.29	225.88	112.94	56.47	NA	ps
		0.42	0.48	0.48	0.48	NA	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	545.88	244.71	122.35	61.18	NA	ps
		0.58	0.52	0.52	0.52	NA	UI
Deterministic Jitter	Jitter@BER; DJ	348.24	155.29	77.65	38.82	NA	ps
		0.37	0.33	0.33	0.33	NA	UI
B	Mask Seg1, Seg3	1000	1000	800	???	???	mV
A	Mask Seg2	200	200	138	???	???	mV
X1 (relative to 0.5UI)	Mask Seg2	-197.65	-112.94	-56.47	???	???	ps
		-0.21	-0.24	-0.24	???	???	UI
X2 (relative to 0.5UI)	Mask Seg2	0.00	0.00	0.00	???	???	ps
		0.00	0.00	0.00	???	???	UI
2*A	Min Eye Height	400	400	276	???	???	mV
2*X1	Min Eye Width	395.29	225.88	112.94	???	???	ps
		0.42	0.48	0.48	???	???	UI
2*B	Differential Amplitude	2000	2000	1600	???	???	mV
Skew	Differential Skew*	200	100	NA	NA	???	ps
Common Mode Voltage, RMS	AC CM Voltage	NA	NA	20	20	???	mV

Decoding the Spec: Speed-TxMedia-InteropPoint-Distance

Speed

800 - 800 -- 800 MBytes/second
400 - 400 -- 400 MBytes/second
200 - 200 -- 200 MBytes/second
100 - 100 -- 100 MBytes/second

Tx Media

SE - unbalanced copper connecting to any interoperability point
DF - balanced copper connecting to any interoperability point

InteropPoint

EL - any electrical point except an EA delta point (includes SN PMD delta points) that assumes a non-equalizing reference receiver (with or without a compliance interconnect)
EA - any electrical point that assumes a specified equalizing reference receiver for measurement

Distance

S - Short

Table 3 – Fibre Channel 'Delta' Test Points

Derived from FC-PI4 Rev 6.01- February 27th, 2007 - Chapter 9							
FibreChannel Specification	**RT-Eye Measurement**	**100-SE-EL-S 100-DF-EL-S***	**200-SE-EL-S 200-DF-EL-S***	**400-DF-EL-S**	**800-DF-EL-S**	**800-DF-EA-S**	
Nominal Bit Rate	Bit Rate	1.0625	2.125	4.250	8.500	8.500	Gb/s
Unit Interval	Unit Interval	941.1765	470.5882	235.2941	117.6471	117.6471	ps
Bit Rate Tolerance	Bit Rate Limits	100	100	100	100	100	PPM
Golden PLL Frequency	1st Order PLL Loop BW	0.64	1.27	2.55	5.10	5.10	MHz

Delta-Tx Test Point							
FibreChannel Specification	**RT-Eye Measurement**	**100-SE-EL-S 100-DF-EL-S***	**200-SE-EL-S 200-DF-EL-S***	**400-DF-EL-S**	**800-DF-EL-S**	**800-DF-EA-S**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	705.88	348.24	174.12	81.18	NA	ps
		0.75	0.74	0.74	0.69	NA	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	235.29	122.35	61.18	36.47	36.47	ps
		0.25	0.26	0.26	0.31	0.31	UI
Deterministic Jitter	Jitter@BER; DJ	112.94	65.88	32.94	20.00	20.00	ps
		0.12	0.14	0.14	0.17	0.17	UI
B	Mask Seg1, Seg3	1000	1000	800	350	350	mV
A	Mask Seg2	325	325	325	90	90	mV
X1 (relative to 0.5UI)	Mask Seg2	-352.94	-174.12	-87.06	-40.59	-40.59	ps
		-0.38	-0.37	-0.37	-0.35	-0.35	UI
X2 (relative to 0.5UI)	Mask Seg2	-174.12	-84.71	-42.35	-18.24	-18.24	ps
		-0.19	-0.18	-0.18	-0.16	-0.16	UI
2*A	Min Eye Height	650	650	650	180	???	mV
2*X1	Min Eye Width	705.88	348.24	174.12	81.18	???	ps
		0.75	0.74	0.74	0.69	???	UI
2*B	Differential Amplitude	2000	2000	1600	700	700	mV
Rise/Fall Time 20-80%	Max Rise/Fall Time	385	NA	NA	NA	NA	ps
Rise/Fall Time 20-80%	Min Rise/Fall Time	100	NA	NA	NA	NA	ps
Skew	Differential Skew*	20	NA	NA	NA	NA	ps
Common Mode Voltage, RMS	AC CM Voltage	NA	NA	15	15	15	mV

Delta-Rx Test Point							
FibreChannel Specification	**RT-Eye Measurement**	**100-SE-EL-S 100-DF-EL-S***	**200-SE-EL-S 200-DF-EL-S***	**400-DF-EL-S**	**800-DF-EL-S**	**800-DF-EA-S**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	414.12	192.94	96.47	34.12	NA	ps
		0.44	0.41	0.41	0.29	NA	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	527.06	277.65	138.82	83.53	NA	ps
		0.56	0.59	0.59	0.71	NA	UI
Deterministic Jitter	Jitter@BER; DJ	338.82	183.53	91.76	49.41	NA	ps
		0.36	0.39	0.39	0.42	NA	UI
B	Mask Seg1, Seg3	1000	1000	800	425	425	mV
A	Mask Seg2	185	185	185	170	112.5	mV
X1 (relative to 0.5UI)	Mask Seg2	-207.06	-96.47	-48.24	-17.06	NA	ps
		-0.22	-0.21	-0.21	-0.15	NA	UI
X2 (relative to 0.5UI)	Mask Seg2	0.00	0.00	0.00	0.00	NA	ps
		0.00	0.00	0.00	0.00	NA	UI
2*A	Min Eye Height	370	370	370	340	225	mV
2*X1	Min Eye Width	414.12	192.94	96.47	34.12	NA	ps
		0.44	0.41	0.41	0.29	NA	UI
2*B	Differential Amplitude	2000	2000	1600	850	850	mV
Skew	Differential Skew*	205	105	NA	NA	???	ps
Common Mode Voltage, RMS	AC CM Voltage	NA	NA	15	15	15	mV

Table 4 – Fibre Channel 'Gamma' Test Points

Derived from FC-PI4 Rev 6.01- February 27th, 2007 - Chapter 9							
FibreChannel Specification	**RT-Eye Measurement**	**100-SE-EL-S 100-DF-EL-S***	**200-SE-EL-S 200-DF-EL-S***	**400-DF-EL-S**	**800-DF-EL-S**	**800-DF-EA-S**	
Nominal Bit Rate	Bit Rate	1.0625	2.125	4.250	8.500	8.500	Gb/s
Unit Interval	Unit Interval	941.1765	470.5882	235.2941	117.6471	117.6471	ps
Bit Rate Tolerance	Bit Rate Limits	100	100	100	100	100	PPM
Golden PLL Frequency	1st Order PLL Loop BW	0.64	1.27	2.55	5.10	5.10	MHz

Gamma-Tx Test Point							
FibreChannel Specification	**RT-Eye Measurement**	**100-SE-EL-S 100-DF-EL-S***	**200-SE-EL-S 200-DF-EL-S***	**400-DF-EL-S**	**800-DF-EL-S**	**800-DF-EA-S**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	687.06	329.41	101.18	NA	NA	ps
		0.73	0.70	0.43	NA	NA	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	254.12	141.18	134.12	NA	NA	ps
		0.27	0.30	0.57	NA	NA	UI
Deterministic Jitter	Jitter@BER; DJ	122.35	75.29	87.06	NA	NA	ps
		0.13	0.16	0.37	NA	NA	UI
B	Mask Seg1, Seg3	1000	1000	800	???	???	mV
A	Mask Seg2	550	550	155	???	???	mV
X1 (relative to 0.5UI)	Mask Seg2	-343.53	-164.71	-50.59	???	???	ps
		-0.37	-0.35	-0.22	???	???	UI
X2 (relative to 0.5UI)	Mask Seg2	-164.71	-75.29	0.00	???	???	ps
		-0.18	-0.16	0.00	???	???	UI
2*A	Min Eye Height	1100	1100	310	???	???	mV
2*X1	Min Eye Width	687.06	329.41	101.18	???	???	ps
		0.73	0.70	0.43	???	???	UI
2*B	Differential Amplitude	2000	2000	1600	???	???	mV
Rise/Fall Time 20-80%	Max Rise/Fall Time	385.00	192.00	NA	???	???	ps
Rise/Fall Time 20-80%	Min Rise/Fall Time	100	75	60	???	???	ps
Skew	Differential Skew*	25	15	NA	???	???	ps
Common Mode Voltage, RMS	AC CM Voltage	NA	NA	15	15	???	mV

Gamma-Rx Test Point							
FibreChannel Specification	**RT-Eye Measurement**	**100-SE-EL-S 100-DF-EL-S***	**200-SE-EL-S 200-DF-EL-S***	**400-DF-EL-S**	**800-DF-EL-S**	**800-DF-EA-S**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	432.94	202.35	101.18	???	NA	ps
		0.46	0.43	0.43	???	NA	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	508.24	268.24	134.12	???	NA	ps
		0.54	0.57	0.57	???	NA	UI
Deterministic Jitter	Jitter@BER; DJ	329.41	174.12	87.06	???	NA	ps
		0.35	0.37	0.37	???	NA	UI
B	Mask Seg1, Seg3	1000	1000	800	???	NA	mV
A	Mask Seg2	200	200	138	???	NA	mV
X1 (relative to 0.5UI)	Mask Seg2	-216.47	-101.18	-50.59	???	NA	ps
		-0.23	-0.22	-0.22	???	NA	UI
X2 (relative to 0.5UI)	Mask Seg2	0.00	0.00	0.00	???	???	ps
		0.00	0.00	0.00	???	???	UI
2*A	Min Eye Height	400	400	276	???	???	mV
2*X1	Min Eye Width	432.94	202.35	101.18	???	???	ps
		0.46	0.43	0.43	???	???	UI
2*B	Differential Amplitude	2000	2000	1600	???	???	mV
Skew	Differential Skew*	200	100	NA	NA	???	ps
Common Mode Voltage, RMS	AC CM Voltage	NA	NA	20	???	???	mV

6.3 Ethernet (XAUI and 10GBaseCX4)

Table 5 – XAUI Compliance Test Points

Derived from IEEE 802.3ae-2002 (XAUI - 10G Attachment Unit Interface)				
IEEE 802.3ae 'XAUI' Specification	**RT-Eye Measurement**	**XAUI Near End**	**XAUI Far End**	
Nominal Bit Rate	Bit Rate	3.125	3.125	Gb/s
Unit Interval	Unit Interval	320.0000	320.0000	ps
Bit Rate Tolerance	Bit Rate Limits	100	100	PPM
Golden PLL Frequency	1st Order PLL Loop BW	1.87	1.87	MHz

Section 47.3 XAUI Driver Electrical characteristics (Table 47-1 & Figure 47-4)				
IEEE 802.3ae 'XAUI' Specification	**RT-Eye Measurement**	**XAUI Near End**	**XAUI Far End**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	208.00	144.00	ps
		0.65	0.45	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	112.00	176.00	ps
		0.35	0.55	UI
Deterministic Jitter	Jitter@BER; DJ	54.40	118.40	ps
		0.17	0.37	UI
A2	Mask Seg1, Seg3	800	800	mV
A1	Mask Seg2	400	100	mV
X1 (relative to 0.5UI)	Mask Seg2	-104.00	-72.00	ps
		-0.325	-0.225	UI
X2 (relative to 0.5UI)	Mask Seg2	-35.20	-32.00	ps
		-0.110	-0.100	UI
2*A1	Min Eye Height	800	200	mV
2*X1	Min Eye Width	208.00	144.00	ps
		0.65	0.45	UI
2*VDIFFmax	Differential Amplitude	1600	1600	mV
Rise/Fall Time 20-80%	Max Rise/Fall Time	130	130	
Rise/Fall Time 20-80%	Min Rise/Fall Time	60	60	ps

Table 6 – 10GBaseCX4 Compliance Test Points

Derived from IEEE Std. 802.3ak-2004			
10GBASE-CX4 Specification	**RT-Eye Measurement**	**3.125Gb/s**	
Nominal Bit Rate	Bit Rate	3.1250	Gb/s
Unit Interval	Unit Interval	320.0000	ps
Bit Rate Tolerance	Bit Rate Limits	100	PPM
Golden PLL Frequency	1st Order PLL Loop BW	1.875	MHz

From Table 54-3 MDI Transmitter Specification (at TP2 in Figure 54-2)			
10GBASE-CX4 Specification	**RT-Eye Measurement**	**1.25Gb/s Short Run**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	208.00	ps
		0.65	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	112.00	ps
		0.35	UI
Deterministic Jitter	Jitter@BER; DJ	54.40	ps
		0.17	UI
Deterministic Jitter	Jitter@BER; RJ	86.40	ps
		0.27	UI
Differential Pk-Pk/2 max	Mask Seg1, Seg3	600	mV
Differential Pk-Pk/2 min	Mask Seg2	400	mV
Jitter Mask	Mask Seg2	-104	ps
		-0.33	UI
2*VDIFFmax	Min Eye Height	800	mV
2*Jitter Mask	Min Eye Width	208	ps
		0.65	UI
Differential Pk-Pk Output Voltage	Differential Amplitude	1200	mV
Rise/Fall Time 20-80%	Max Rise/Fall Time	130	ps
Rise/Fall Time 20-80%	Min Rise/Fall Time	60	ps

6.4 InfiniBand DDR (Dual Data Rate) and QDR (Quad Data Rate)

Table 7 – InfiniBand Compliance Test Points

Derived from InfiniBand Architecture Specification Volume 2 - Release 1.2 - October, 2004								
InfiniBand Specification	**RT-Eye Measurement**	**5.0Gb/s DDR TX_PINS**	**5.0Gb/s DDR TP6**	**5.0Gb/s DDR TP1**	**5.0Gb/s QDR TX_PINS**	**10.0Gb/s QDR TP6**	**10.0Gb/s QDR TP1**	
Nominal Bit Rate	Bit Rate	5.0000	5.0000	5.000	10.000	10.000	10.000	Gb/s
Unit Interval	Unit Interval	200.0000	200.0000	200.0000	100.0000	100.0000	100.0000	ps
Bit Rate Tolerance	Bit Rate Limits	100	100	100	100	100	100	PPM
Golden PLL Frequency	1st Order PLL Loop BW	3.00	3.00	3.00	6.00	6.00	6.00	MHz

Table 18 and Table 19 Driver Characteristics								
InfiniBand Specification	**RT-Eye Measurement**	**5.0Gb/s DDR TX_PINS**	**5.0Gb/s DDR TP6**	**5.0Gb/s DDR TP1**	**5.0Gb/s QDR TX_PINS**	**10.0Gb/s QDR TP6**	**10.0Gb/s QDR TP1**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	140.00	140.00	140.00	70.00	70.00	70.00	ps
		0.70	0.70	0.70	0.70	0.70	0.70	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	60.00	60.00	60.00	30.00	30.00	30.00	ps
		0.30	0.30	0.30	0.30	0.30	0.30	UI
Deterministic Jitter	Jitter@BER; DJ	30.00	30.00	30.00	15.00	15.00	15.00	ps
		0.15	0.15	0.15	0.15	0.15	0.15	UI
Vdiff (TX_PINS)	Min Eye Height	800			600			mV
Vdiffc (TP6)	Min Eye Height		650			500		mV
Vdiff (TP1)	Min Eye Height			600			450	mV
Vdiff	Differential Amplitude	800	650	600	600	500	450	mV
Rise/Fall Time 20-80%	Min Rise/Fall Time	30	30	30	30	30	30	ps
Common Mode Voltage, RMS	AC CM Voltage	25	25	25	25	25	25	mV

6.5 Open Base Station Architecture Initiative (OBSAI)

Table 8 – OBSAI Compliance Test Points

OBSAI (Open Base Station Achritecture Initiative) Reference Point 3 Specification Ver. 1.3					
OBSAI Specification	**RT-Eye Measurement**	**768Mb/s**	**1.536Gb/s**	**3.072Gb/s**	
Nominal Bit Rate	Bit Rate	0.7680	1.536	3.072	Gb/s
Unit Interval	Unit Interval	1302.0833	651.0417	325.5208	ps
Bit Rate Tolerance	Bit Rate Limits	100	100	100	PPM
	Min Unit Interval	1301.95313	650.97656	325.48828	ps
	Max Unit Interval	1302.21354	651.10677	325.55339	ps
Golden PLL Frequency	1st Order PLL Loop BW	0.46	0.92	1.84	MHz
		651.04	325.52	162.76	

Section 5.3 Transmitter Specifications					
OBSAI Specification	**RT-Eye Measurement**	**768Mb/s**	**1.536Gb/s**	**3.072Gb/s**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	846.35	423.18	211.59	ps
		0.65	0.65	0.65	UI
Total Jitter at 10-15 BER	Jitter@BER; TJ	455.73	227.86	113.93	ps
		0.35	0.35	0.35	UI
Deterministic Jitter	Jitter@BER; DJ	221.35	110.68	55.34	ps
		0.17	0.17	0.17	UI
A2	Mask Seg1, Seg3	800	800	800	mV
A1	Mask Seg2	200	200	200	mV
X1 (relative to 0.5UI)	Mask Seg2	-423.18	-211.59	-105.79	ps
		-0.325	-0.325	-0.325	UI
X2 (relative to 0.5UI)	Mask Seg2	-143.23	-71.61	-35.81	ps
		-0.11	-0.11	-0.11	UI
Min Differential Voltage (2*A1)	Min Eye Height	400	400	400	mV
Eye Width	Min Eye Width	846.35	423.18	211.59	ps
		0.65	0.65	0.65	UI
Max Differential Voltage (2*A2)	Differential Amplitude	1600	1600	1600	mV

Section 8.7 Receiver Eye Diagrams					
OBSAI Specification	**RT-Eye Measurement**	**768Mb/s**	**1.536Gb/s**	**3.072Gb/s**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	585.94	292.97	146.48	ps
		0.45	0.45	0.45	UI
Total Jitter at 10-15 BER	Jitter@BER; TJ	716.15	358.07	179.04	ps
		0.55	0.55	0.55	UI
Deterministic Jitter	Jitter@BER; DJ	481.77	240.89	120.44	ps
		0.37	0.37	0.37	UI
A2	Mask Seg1, Seg3	800	800	800	mV
A1	Mask Seg2	100	100	100	mV
X1 (relative to 0.5UI)	Mask Seg2	-292.97	-146.48	-73.24	ps
		-0.225	-0.225	-0.225	UI
X2 (relative to 0.5UI)	Mask Seg2	0.00	0.00	0.00	ps
		0.00	0.00	0.00	UI
Max Differential Voltage (2*A2)	Differential Amplitude	1600	1600	1600	mV
Min Differential Voltage (2*A1)	Min Eye Height	200	200	200	mV
Eye Width	Min Eye Width	585.94	292.97	146.48	ps

6.6 Serial Attached SCSI (SAS)

Table 9 – SAS Compliance Test Points

Derived from ANSI INCITS 417-2006 SAS-1.1 Specification and T10/07-063r7 May 21, 2007							
SAS Specification	**RT-Eye Measurement**	**1.5Gb/s**	**1.5Gb/s**	**3.0Gb/s**	**3.0Gb/s**	**6Gb/s**	
Nominal Bit Rate	Bit Rate	1.5000	1.5000	3.000	3.000	6.000	Gb/s
Unit Interval	Unit Interval	666.6667	666.6667	333.3333	333.3333	166.6667	ps
Bit Rate Tolerance	Bit Rate Limits	100	100	100	100	100	PPM
	Min Unit Interval	666.60000	666.60000	333.30000	333.30000	166.65000	ps
	Max Unit Interval	666.73333	666.73333	333.36667	333.36667	166.68333	ps
Golden PLL Frequency	1st Order PLL Loop BW	0.90	0.90	1.80	1.80	3.60	MHz
		333.33	333.33	166.67	166.67	83.33	

Section 5.3.3 Transmitter with zero length test load							
SAS Specification	**RT-Eye Measurement**	**IT Test Point 1.5Gb/s**	**CT Test Point 1.5Gb/s**	**IT Test Point 3.0Gb/s**	**CT Test Point 3.0Gb/s**	**6Gb/s**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	300.00	300.00	150.00	150.00	66.67	ps
		0.45	0.45	0.45	0.45	0.40	UI
Total Jitter at 10-15 BER	Jitter@BER; TJ	366.67	366.67	183.33	183.33	100.00	ps
		0.55	0.55	0.55	0.55	0.60	UI
Deterministic Jitter	Jitter@BER; DJ	233.33	233.33	116.67	116.67	58.33	ps
		0.35	0.35	0.35	0.35	0.35	UI
Z2	Mask Seg1, Seg3	800	800	800	800	600	mV
Z1	Mask Seg2	162.5	137.5	162.5	137.5	50	mV
X1 (relative to 0.5UI)	Mask Seg2	-150.00	-150.00	-75.00	-75.00	-33.33	ps
		-0.225	-0.225	-0.225	-0.225	-0.200	UI
Min Differential Voltage (2*Z1)	Min Eye Height	325	275	275	275	100	mV
Eye Width	Min Eye Width	300.00	300.00	150.00	150.00	66.67	ps
		0.45	0.45	0.45	0.45	0.40	UI
AC CM Voltage (pk-Pk)	AC CM Voltage (pk-Pk)	150	150	150	150	150	mV
Rise/Fall Time 20-80%	Max Rise/Fall Time	273	273	137	137	68.33	ps
Rise/Fall Time 20-80%	Min Rise/Fall Time	67	67	67	67	41.67	ps
Skew	Max Differential Skew*	20	20	15	15	NA	ps

Section 5.3.5 Transmitter/Receiver with TCTF (Transmitter Compliance Transfer Function)							
SAS Specification	**RT-Eye Measurement**	**IT Test Point 1.5Gb/s**	**CT Test Point 1.5Gb/s**	**IT Test Point 3.0Gb/s**	**CT Test Point 3.0Gb/s**		
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	300.00	300.00	150.00	150.00		ps
		0.45	0.45	0.45	0.45		UI
Total Jitter at 10-15 BER	Jitter@BER; TJ	366.67	366.67	183.33	183.33		ps
		0.55	0.55	0.55	0.55		UI
Deterministic Jitter	Jitter@BER; DJ	233.33	233.33	116.67	116.67		ps
		0.35	0.35	0.35	0.35		UI
Z2	Mask Seg1, Seg3	800	800	800	800		mV
Z1	Mask Seg2	162.5	137.5	137.5	137.5		mV
X1 (relative to 0.5UI)	Mask Seg2	-150.00	-150.00	-75.00	-75.00		ps
		-0.225	-0.225	-0.225	-0.225		UI
Min Differential Voltage (2*Z1)	Min Eye Height	325	275	275	275		mV
Eye Width	Min Eye Width	300.00	300.00	150.00	150.00		ps
		0.45	0.45	0.45	0.45		UI
AC CM Voltage (pk-Pk)	AC CM Voltage (pk-Pk)	150	150	150	150		mV
Rise/Fall Time 20-80%	Max Rise/Fall Time	273	273	137	137		ps
Rise/Fall Time 20-80%	Min Rise/Fall Time	67	67	67	67		ps
Skew	Max Differential Skew*	80	80	75	75		ps
Max Pk-Pk Voltage (2*Z2)	Differential Amplitude	1600	1600	1600	1600		mV

6.7 Serial RapidIO

Table 10 – Serial RapidIO Compliance Test Points

Derived from RapidIO Interconnect Specification - Rev1.3 - June 2005								
RapidIO Specification	**RT-Eye Measurement**	**1.25Gb/s Short Run**	**1.25Gb/s Long Run**	**2.5Gb/s Short Run**	**2.5Gb/s Long Run**	**3.125Gb/s Short Run**	**3.125Gb/s Long Run**	
Nominal Bit Rate	Bit Rate	1.2500	1.250	2.500	2.500	3.125	3.125	Gb/s
Unit Interval	Unit Interval	800.0000	800.0000	400.0000	400.0000	320.0000	320.0000	ps
Bit Rate Tolerance	Bit Rate Limits	100	100	100	100	100	100	PPM
Golden PLL Frequency	1st Order PLL Loop BW	0.75	0.75	1.50	1.50	1.87	1.87	MHz

Section 8.5 Transmitter Specifications								
RapidIO Specification	**RT-Eye Measurement**	**1.25Gb/s Short Run**	**1.25Gb/s Long Run**	**2.5Gb/s Short Run**	**2.5Gb/s Long Run**	**3.125Gb/s Short Run**	**3.125Gb/s Long Run**	
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	520.00	520.00	260.00	260.00	208.00	208.00	ps
		0.65	0.65	0.65	0.65	0.65	0.65	UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	280.00	280.00	140.00	140.00	112.00	112.00	ps
		0.35	0.35	0.35	0.35	0.35	0.35	UI
Deterministic Jitter	Jitter@BER; DJ	136.00	136.00	68.00	68.00	54.40	54.40	ps
		0.17	0.17	0.17	0.17	0.17	0.17	UI
VDIFFmax	Mask Seg1, Seg3	500	800	500	800	500	800	mV
VDIFFmin	Mask Seg2	250	400	250	400	250	400	mV
A (relative to 0.5UI)	Mask Seg2	-260.00	-260.00	-130.00	-130.00	-104.00	-104.00	ps
		-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	UI
B (relative to 0.5UI)	Mask Seg2	-88.00	-88.00	-44.00	-44.00	-35.20	-35.20	ps
		-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	UI
2*VDIFFmax	Min Eye Height	500	800	500	800	500	800	mV
2A	Min Eye Width	520.00	520.00	260.00	260.00	208.00	208.00	ps
		0.65	0.65	0.65	0.65	0.65	0.65	UI
2*VDIFFmax	Differential Amplitude	1000	1600	1000	1600	1000	1600	mV
Rise/Fall Time 20-80%	Min Rise/Fall Time	60	60	60	60	60	60	ps
Skew	Differential Skew*	25	25	20	20	15	15	ps

Section 8.7 Receiver Eye Diagrams								
RapidIO Specification	**RT-Eye Measurement**	**1.25Gb/s**		**2.5Gb/s**		**3.125Gb/s**		
1UI - Total Jitter	Jitter@BER; Jitter Eye Opening	360.00		180.00		144.00		ps
		0.45		0.45		0.45		UI
Total Jitter at 10-12 BER	Jitter@BER; TJ	440.00		220.00		176.00		ps
		0.55		0.55		0.55		UI
VDIFFmax	Mask Seg1, Seg3	800		800		800		mV
VDIFFmin	Mask Seg2	100		100		100		mV
X1 (relative to 0.5UI)	Mask Seg2	-180.00		-90.00		-72.00		ps
		-0.23		-0.23		-0.23		UI
X2 (relative to 0.5UI)	Mask Seg2	-80.00		-40.00		-32.00		ps
		-0.10		-0.10		-0.10		UI
2*VDIFFmin	Min Eye Height	200		200		200		mV
2*A	Min Eye Width	360.00		180.00		144.00		ps
		0.45		0.45		0.45		UI
2*B	Differential Amplitude	1600		1600		1600		mV
Skew	Differential Skew*	200		202		204		ps

7 Appendix A - Customizing Standards Support Library Files

Each standard support setup file consists of three files; the RT-Eye Serial Analysis setup file <*filename.ini*>, the Mask file <*filename.msk*>, and the limits file <*filename.lim*>. All three of these files can be customized if the user chooses to do so.

7.1 Customizing Setup Files

The setup file can be changed by the user and resaved if desired. For example, the default configuration is Single Ended Ch1, Ch3. If a differential probe is being used it may be desirable to save a file in the library that has Differential Ch1 as the source.

7.2 Customizing Mask Files

The .msk files follow the Tektronix format that defines the mask geometries into three absolute segments. The Mask geometries of interest in the InfiniBand DDR TP6 example are highlighted in the following figure. The mask file is a text file and can be edited with a text editor program such as MS Notepad.

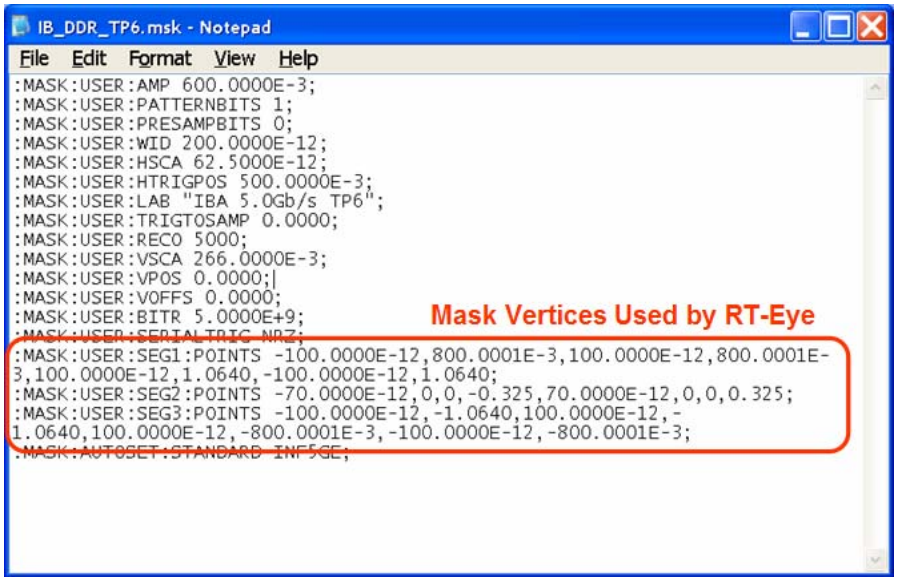


Figure 8 – InfiniBand TP6 Mask File

It is recommended that a Standards Support Library Mask file is copied and renamed before editing.

7.3 Customizing Limits Files

The .lim files follow the Tektronix format that defines the measurement limits in the Serial Analysis Module.

Limits files can be customized by going to the Measurement > Limits menu in the RT-Eye Serial Analysis Module. The current Limits file can be opened and resaved with new limits.

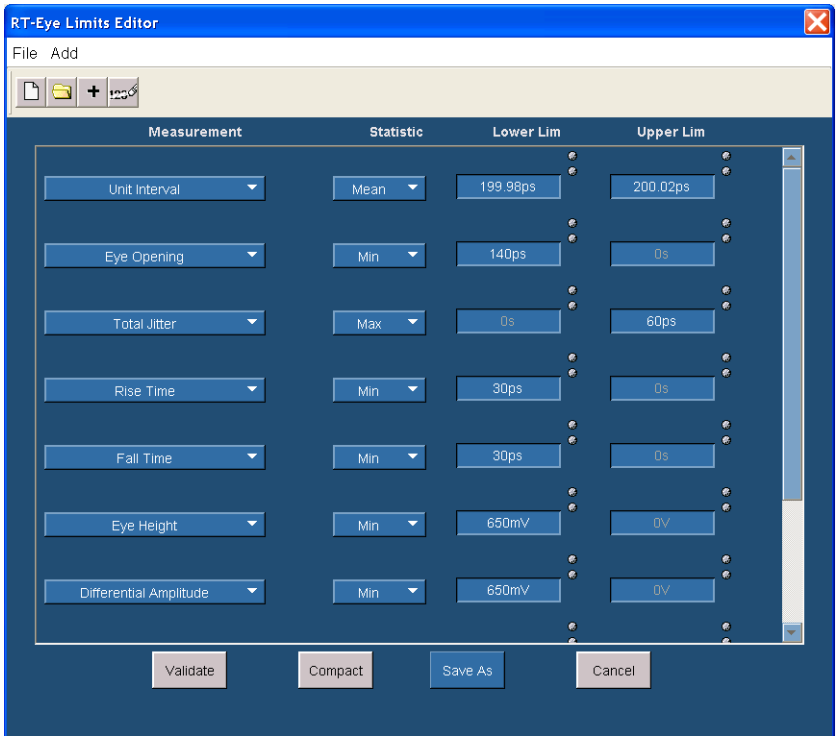


Figure 9 – InfiniBand TP6 Limits File

It is recommended that a Standards Support Library limits file is copied and renamed before editing.

8 Appendix B – Measurement Algorithms

Refer to the RT-Eye OLH Measurement Algorithms section.