Proposed Draft | **Serial ATA International Organization**

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Title : Asymmetric Amplitude and Revisions to Minimum Amplitude Measurement Methodology.

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Document History

Version	Date	Comments
0.10	02/20/2011	Initial release.
0.20	02/22/2011	Updated to include issued ECN 50 number, and remove EIA364 reference.
0.30	02/23/2011	Edits made during Phy call on 2/23/2011
0.40	02/23/2011	Added references
0.50	04/01/2011	Post Technical Integration Committee Review
0.51	04/04/2011	Clarification on calibration statements.

1 Introduction

1.1 Problem Statement

To date, early SATA 6G solutions have been designed around special purpose SATA Phy's connected via PCIE into the PC's IO bus structure. This has allowed relatively tight co-location of the SATA Phy in proximity to the ~~i~~SATA connector as the placement of the special purpose SATA 6G Phy is relatively unconstrained. The advent of higher volume PC SATA IO systems served out of a central Platform Controller Hub, layout requires designers to target 6~~-10~~" traces between the ~~i~~SATA connector and the driving controller. This is the basis of the position which asserts the signaling model requires a provision to support an asymmetrical minimum amplitude specification. A higher minimum incident signal is required (proposed 40 mV higher) on a host input that that found on a device. It is proposed that a host input have a 240mV minimum specification, while devices be reduced to 200mV.

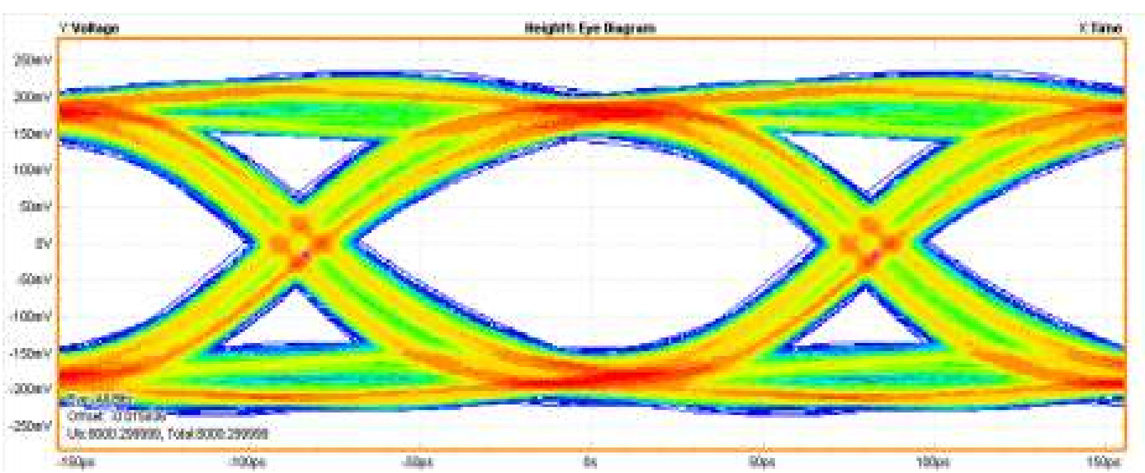
The minimum measurement methodology is also being revised in this proposal.
The currently spec'd BER based 1~~0~~E-12 amplitude measurements technique has been problematic from a correlation standpoint between different instruments. When the specified noise correction factors of Spec section 7.4.3.2 have been applied, the instruments examined in this study are not capable of NIST traceable amplitude measurements. At this time BERTs commonly used for these measurements do not provide specifications of vertical amplitude accuracy.
The proposed solution to this problem is to build a relatively simple measurement (Eye-Diagram) on an instrument with NIST traceable specifications of vertical amplitude measurement accuracy.

This ECN will also include an addition of a df/dt requirement for Gen3i identical to the existing Gen1i Gen2i requirement.

1.2 Solution Summary

As the trace-length requirement for the Disc-Drive/Device side of the ~~i~~SATA 6Gbps interface is significantly shorter than 6-inches, this ECN proposes that the minimum signaling levels at the ~~i~~SATA Rx-compliance point for the Device-side be reduced from 240mV down to 200mV. The Rx-compliance point for the Host-side will retain the current 240mV minimum requirement.

The methodology would be revised from a 1~~0~~E-12 BER contour to a 4 Sigma Eye Diagram constructed from a minimum 5E6 number of unit intervals.



4Sigma Eye Diagram

The proposed signal levels would be as follows:

Receiver Test Calibration levels and method details.
200mV for Drive side receiver (Eye Height +CIC + Explicit Clock)
240mV for the Host side receiver (Eye Height +CIC + Explicit Clock)

Transmitter Test levels and method details.
240mV for Drive side transmitter minimum (Eye Height +CIC + JTF PLL)
200mV for the Host side transmitter minimum (Eye Height + CIC + JTF PLL)

1.3 Background (optional)

Note: Explicit Clock in this context is to perform one of the following: Acquire a record and extract the mean period, and use that through all the jitter calculations. Alternately in BERT or ET based measurement solutions an explicit clock is a bit timed reference clock typically sourced from a precision generator.

The reason different Tx and Rx clock recovery systems are applied are due to their respective strengths.

Explicit clock based recovery.
Pros:
Precision. It removes the vagaries of clock recovery PLL differences.
Cons:
It integrates all the noise contributions from Nyquist up to the bandwidth of the instrument. Used in conjunction with precision generators this is not a significant problem.
SSC is not supported using explicit clock methods of clock recovery.

PLL base clock recovery.
Pros:
Sees the signal like the receiver does.
Tracks (rejects) low frequency jitter in line with the transfer function of the JTF model.
Cons:
The JTF model in the specification for Gen3i, requires a 4.2MHz PLL Fc with +/-2 MHz of allowable variation. This would permit placement of the PLL Fc at either 2.2MHz or 6.2MHz and be within specifications.

7.3.2.3 Gen3i Normative Requirements

For Gen3i the Reference Clock characteristics are controlled by the resulting JTF (Jitter Transfer Function) characteristics obtained by taking the time difference between the Type 2 PLL output (the Reference Clock) and the data stream sourced to the PLL. The PLL CLTF -3 dB corner frequency, and other adjustable CLTF parameters such a peaking, are determined by the value required to meet the requirements of the JTF. (See section 7.4.8 for JTF information)

The JTF for Gen3i shall have the following characteristics for an encoded Gen3 D24.3 pattern (1100110011 0011001100). This is the Gen3 MFTP, which is a test pattern that has clock-like characteristics and a transition density of 0.5.

1) The -3 dB corner frequency of the JTF shall be 4.2 MHz +/- 2 MHz. as shown in Table 36 Jitter Transfer Function Bandwidth (D24.3, high pass -3dB)(Gen3).
2) The magnitude peaking of the JTF shall be 3.5 dB maximum. as showna in Table 36 Jitter Transfer Function Peaking (Gen3).
3) The attenuation at 420 KHz +/- 1% Jitter Transfer Function Low Frequency Attenuation Measurement Frequency (Gen3) in Table 36 shall be 38.2 dB +/- 3 dB. as shown in Table 36 Jitter Transfer Function Low Frequency Attenuation (Gen3).

This amount of variation in light of LOGO compliance test frequencies of 5MHz (and others) can be substantial if Fc was at 6.2MHz –vs- 2.2 MHz.

2 Technical Specification Changes

2.1 <Title of section being changed>

[**Editor's Note:** The changes marked in red (and underlined/strikethrough) will be incorporated in section XXX]

<3.3> Other references

National Institute of Standards and Technology (NIST): http://www.nist.gov
HBWS Instruments could be calibrated and be traceable to ~~**[Editor's Note: add specific document reference]**~~ISO/IEC 17025:2005 specifications

<7.2> Electrical Specifications

The goal of this specification is to provide a description of characteristics to ensure interoperability of SATA components; devices, hosts, and interconnects. Any combination of compliant components should provide the stated link performance. Secondly a means of validation to the requirements is described in section 7.4. Validation consists of performing tests on individual SATA components.

Serial ATA devices and hosts shall comply with the electrical specifications shown in Table 34, Table 35, Table 36, Table 37, Table 38, and Table 39. The transmitter consists of the driver integrated circuit (IC), printed circuit board, and mated connector pair. The receiver consists of the receiver IC, printed circuit board, and mated connector pair.

Unless otherwise stated, all specifications include the mated connector pair.

Table 1 – General Specifications

Parameters	Units	Limit	Electrical Specification					Detail Cross-Ref Section	Measurement Cross-Ref Section
			Gen1i	Gen1m	Gen2i	Gen2m	Gen3i		
SSC_{tol}, Spread-Spectrum Modulation Rate	ppm/ usec	Max	1250		1250		1250-	7.2.2.1.6 7.3.3	7.4.15

Table 2 – Transmitted Signal Requirements

Parameter	Units	Limit	Electrical Specification					Detail Cross-Ref Section	Measurement Cross-Ref Section
			Gen1i	Gen1m	Gen2i	Gen2m	Gen3i		
$V_{diffTXdevice}$, TX Differential Device Output Voltage	mVppd	Min	400		400		-	7.2.2.3	7.4.6
		Min	-		-		240		7.4.4 7.4.4.3
		Nom	500		-		-		7.4.6
		Max	600		700		-		
		Max	-		-		900		7.4.4

Parameter	Units	Limit	Electrical Specification					Detail Cross-Ref Section	Measurement Cross-Ref Section
			Gen1i	Gen1m	Gen2i	Gen2m	Gen3i		
$V_{diffTXhost}$, TX Differential Host Output Voltage	mVppd	Min	400		400		-	7.2.2.3	7.4.6
		Min	-		-		200~~240~~		7.4.4 7.4.4.3
		Nom	500		-		-		7.4.6
		Max	600		700		-		
		Max	-		-		900		7.4.4
UI_{VminTX}, TX Minimum Voltage Measurement Interval	UI		0.45-0.55		0.45-0.55		-	**Error! Reference source not found.**~~7.2.2.3.2~~	**Error! Reference source not found.**~~7.4.6~~
			-		-		~~0.50~~ 0.45-0.55		**Error! Reference source not found.**~~7.4.6.2~~

Table 3 – Lab-Sourced Signal (for Receiver Tolerance Testing)

Parameter	Units	Limit	Electrical Specification					Detail Cross-Ref Section	Measurement Cross-Ref Section
			Gen1i	Gen1m	Gen2i	Gen2m	Gen3i		
$V_{diffRXdevice}$, RX Differential Device Input Voltage	mVppd	Min	325	240	275	240	-	7.2.2.4.7	7.4.7
		Min	-		-		200~~240~~		7.4.4 7.4.4.3 7.4.13
		Nom	400		-		-		7.4.7
		Max	600		750		-		
		Max	-		-		1000		7.4.4 7.4.13
$V_{diffRXhost}$, RX Differential Host Input Voltage		Min	325	240	275	240	-	7.2.2.4.7	7.4.7
	mVppd	Min	-		-		240		7.4.4 7.4.4.3 7.4.13
		Nom	400		-		-		7.4.7
		Max	600		750		-		
		Max	-		-		1000		7.4.4 7.4.13
$t_{20-80RX}$, RX Rise/Fall Time	ps (UI)	Min 20-80%	100 (.15)		67 (.20)		-	7.2.2.6.4	7.4.4
			-		-		62 (0.37)		7.4.4 7.4.12
		Max 20-80%	273 (.41)		136 (.41)		-		7.4.4
			-		-		75 (0.45)		7.4.4 **7.4.12**

Parameter	Units	Limit	Electrical Specification					Detail Cross-Ref Section	Measurement Cross-Ref Section
			Gen1i	Gen1m	Gen2i	Gen2m	Gen3i		
UI_{VminRX}, RX Minimum Voltage Measurement Interval	UI		-		0.5		-	7.2.2.4.9	7.4.7
			-		-		~~0.5~~ 0.45 – 0.55		7.4.4.2

<7.4.4.2> Minimum Differential Voltage Amplitude (Gen3i)

The minimum TX differential amplitude shall be measured through the Gen3i CIC as specified in section **Error! Reference source not found.**7.2.7 terminated into the Lab-Load. **Error! Reference source not found.**Figure 157 shows a drawing of this test connection. A Gen3 LBP shall be used for this compliance measurement, although it is possible that with other patterns and signal path characteristics, lower amplitudes may be present in the actual system.

The minimum amplitude is defined as the vertical eye height opening on a population of at least 5 * 10^6 unit intervals of data measured at the minimum voltage measurement interval of the UI using the Gen3i Reference Clock JTF defined in section 7.3.2. When calibrating a receiver stressed signal an explicit clock shall be used instead of the JTF.
The exception to the use of the JTF shall use the explicit clock from an instrument grade generator during receive calibration.

of the 1E-12 BER contour at the 50% point of the UI, when the data is captured using the Gen3i Reference Clock JTF defined in section **Error! Reference source not found.**7.3.2.

The test equipment or JMDs typically used for this measurement include a BERT or a HBWS with appropriate hardware and software to measure or extrapolate a Vertical Bathtub Curve, Eye BER Contour plot, or statistical Eye Opening characteristics. Since some JMDs extrapolate the Eye Opening at the BER target from a smaller population size capture, that measurement is an approximation of the actual Eye Opening. If there are discrepancies between test equipment in the reported Eye Opening at the target BER, the value obtained from a full population vertical BERT scan shall be the standard for this measurement. This is analogous to the horizontal full population BERT scan as being the standard for TJ when measuring jitter.

All test equipment (e.g., HBWS), requires a minimum signal amplitude to be able to measure the eye height to a population of 5 * 10^6 unit intervals 1E-12 BER contour or equivalent data. This level varies with instrumentation type, hardware and software. This minimum required instrumentation amplitude introduces errors in the reported minimum amplitude measurement value. This error results in the minimum amplitude reported by the test equipment to be smaller than the actual signal minimum amplitude. This instrumentation error shall be corrected for, to determine the actual minimum amplitude value using recommended methods provided by the test equipment manufacturer. If no such recommended correction procedure is available for one piece of test equipment, alternate test equipment could be selected. Instrumentation performing this measurement shall be traceable to industry standards setting orgination in the area of performing amplitude measurements (e.g., National Institute of Standards and Technology (NIST) within the USA.

<7.4.4.2.1> Equipment Sensitivity Correction Method (Informative)

[**Editor's Note:** added subsection to make informative nature of section clear]

An alternate approximate correction method could be used in the case of unsupported test equipment. The amplitude of a low noise Lab Source Gen3 MFTP test pattern with the fastest allowed Gen3i rise and fall times is reduced in several steps using passive calibrated attenuators. If the reported amplitude is plotted on the y-axis and the ideal amplitude calculated using the calibrated attenuators and source is plotted on the x-axis, the y-axis intercept represents the theoretical reported amplitude for a zero amplitude input. A linear curve fit to the measured data can extrapolate the measured data to the y-axis intercept. (a negative value) The absolute value of this y-axis intercept is then added as a positive number to the instrument reported minimum Eye Opening values to correct for this error term. Since this is a statistical measurement and the test equipment may contain significant random amplitude variations. This correction method can be in error since it does not convolve the random amplitude variation sources, but it reduces the error magnitude below an uncorrected measurement. This may result in a possible over correction of the instrumentation error term

<7.4.4.3> **Minimum differential amplitude eye height (Gen3i)**

The 4 Sigma Eye Diagram shall be constructed from a population of at least 5 * 10^6 unit intervals with either a JTF based PLL for transmitter testing, or an explicit clock for lab-sourced signal calibration. The explicit clock, or equivalent, from an instrument grade generator shall be used during receive calibration.

<7.4.4.3.1> Receiver Test Calibration levels and method details.

$V_{diffRXdevice}$,RX Differential Device Input Voltage for Drive side receiver (Eye Height + CIC + Explicit Clock)

$V_{diffRXhost}$,RX Differential Host Input Voltage for the Host side receiver (Eye Height + CIC + Explicit Clock)

The Eye Height is to be evaluated at UI_{VminRX},RX Minimum Voltage Measurement Interval.

<7.4.4.3.2> Transmitter Test levels and method details.

$V_{diffTXdevice}$,TX Differential Device Output Voltage for Drive side transmitter minimum (Eye Height + CIC + JTF PLL)

$V_{diffTXhost}$,TX Differential Host Output Voltage for the Host side transmitter minimum (Eye Height + CIC + JTF PLL)

The Eye Height is to be evaluated at UI_{VminTX},TX Minimum Voltage Measurement Interval.