Proposed Draft

Serial ATA International Organization

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Serial ATA Technical Proposal TPR 069
Title: MFTP Measurement Method for Emphasis

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Document History

Version	Date	Comments
0	3/3/2015	Initial release.
1	3/4/2015	Assigned TPR_P103 as the proposal number.
2	3/18/2015	Member review, changed P103 to TPR 069

Introduction

The existing TPR_059 measurement technique is prone to under reporting the actual emphasis, especially for hosts. This issue is a byproduct of arriving at the emphasis value by measuring unrelated waveforms (i.e. HFTP versus LFTP) and also due to using bit 4 of the LFTP which most of the time ends up having relatively high amplitude due the charging effect typical for lossy channel hosts. As a result, when the two unrelated waveforms (i.e. HFTP and LFTP) are compared, an unrealistically low emphasis value is calculated which contradicts the whole intent of TPR_059.

When optimizing lossy hosts to provide an ideal 0 dB at the device connector and then observing the eye opening of an LBP at that same point, it was observed that the eye opening varied dramatically depending upon which method was used to optimize the host emphasis. When using an MFTP method to determine the emphasis level, the LBP eye opening increased by as much as 25% over that obtained when using the combination of HFTP and LFTP specified by TPR_059 to determine the emphasis level. Since larger eye openings generally result in better interoperability, setting the emphasis in such a way as to maximize eye openings with rich data patterns is essential in order to gain robust interoperability across the entire SATA ecosystem.

Another issue with TPR_059 is that it creates a more complicated testing methodology instead of using existing methods recognized by other existing standards and common in the industry (e.g. MFTP). Considering this, the more prudent course to take is to stick to industry accepted and well understood methods for measuring emphasis rather than introducing confusion and misleading results with the generally unfamiliar and non-intuitive two pattern approach of TPR_059.

The proposed approach of this TPR is to specify that TX emphasis be calculated from the voltage ratio of the first bit and second bit of MFTP. Both bits are sampled between 0.45 and 0.55 of their respective UIs.

This proposal is being presented by Western Digital.

Make the following Changes to SATA 3.2 as modified by TPR_059. Added text is in blue underline. Deleted text is in ~~red strikeout~~. Existing text is in black.

7.6.33.2.1 Transmitter emphasis measurement overview

Transmitter emphasis is measured by comparing the mean differential voltage of the first bit of ~~H~~MFTP versus the mean differential voltage of the ~~fourth~~ second bit of ~~LFTP~~MFTP. Emphasis specifications in Table 54 and Table 55 shall be met according to the measurement method as defined in 7.6.33.3.

Figures TBDa and TBDb show the test setups for measuring emphasis. The HBWS is the standard for measuring emphasis. The losses in the test connections may be significant so it is prudent to minimize and estimate these.
Several methods may be used to estimate the cabling losses:

a) use two cables of different lengths and compare the losses of each;
b) rely on published data for the cables; or
c) obtain a separate means for measuring the cable loss (e.g., characterization with a network analyzer or power meter).

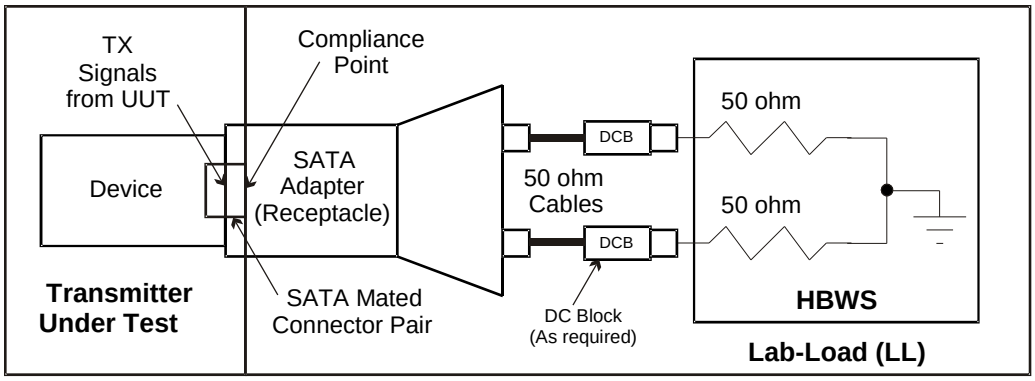

Figure TBDa – Device transmit emphasis test with Lab-Load (LL)

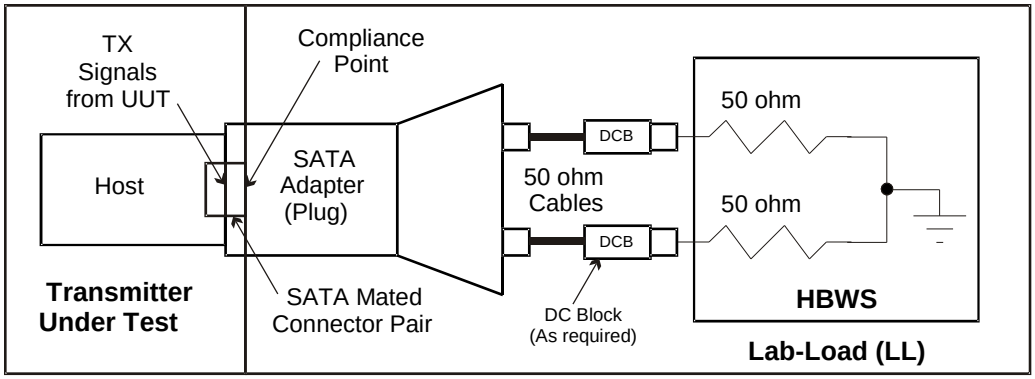

Figure TBDb – Host transmit emphasis test with Lab-Load (LL)

This specification describes emphasis levels in terms of voltage amplitude ratio in dB while driving a test load of 100 ohm differential (i.e., lab-load) and 50 ohm single ended to ground.

7.6.33.3 Measurement of emphasis

To test for emphasis, use the following steps:

Step 1, transmitting an ~~HFTP~~ MFTP pattern, for a unit interval (UI) corresponding to ~~a~~ the first 1 bit, construct a histogram based on n samples collected in the waveform epoch [0.45 UI to 0.55 UI] for the UI. The number of samples in a histogram (n) for the UI shall be greater than or equal to 100 and shall meet the requirement that:

$$1\,537\,(s / \bar{x})^2 \leq n$$

where:

$\bar{x}$ = the mean of the voltage samples in the histogram that may be read from the HBWS in histogram measurement mode

s = the standard deviation of the voltage samples in the histogram that may also be read from the HBWS

n = the number of samples that contribute to the histogram – this may also be read from the HBWS

The inequality above is based on a requirement that enough samples are collected to define a confidence interval with at least 95 % probability and with a width no greater than 10 % of the sample mean.

Call the mean,

$$A = \overline{x}$$

Step 2, transmitting an ~~HFTP~~ MFTP pattern, for a unit interval (UI) corresponding to ~~a~~ the first 0 bit, construct a histogram based on n samples collected in the waveform epoch [0.45 UI to 0.55 UI] for the UI. The number of samples in a histogram (n) for the UI shall be greater than or equal to 100 and shall meet the requirement that:

$$1\,537\,(s / \overline{x})^2 \leq n$$

where:

$\overline{x}$ = the mean of the voltage samples in the histogram that may be read from the HBWS in histogram measurement mode

s = the standard deviation of the voltage samples in the histogram that may also be read from the HBWS

n = the number of samples that contribute to the histogram – this may also be read from the HBWS

Call the mean,

$$B = \overline{x}$$

Step 3, transmitting an ~~LFTP~~ MFTP pattern, construct a histogram based on n samples collected in the waveform epoch [0.45 UI to 0.55 UI] for the UI of the last 1 bit ~~in a string of four 1 bits~~. The number of samples in a histogram (n) for the UI shall be greater than or equal to 100 and shall meet the requirement that:

$$1\,537\,(s / \overline{x})^2 \leq n$$

where:

$\overline{x}$ = the mean of the voltage samples in the histogram that may be read from the HBWS in histogram measurement mode

s = the standard deviation of the voltage samples in the histogram that may also be read from the HBWS

n = the number of samples that contribute to the histogram – this may also be read from the HBWS

Call the mean,

$$C = \overline{x}$$

Step 4, transmitting an ~~LFTP~~ MFTP pattern, construct a histogram based on n samples collected in the waveform epoch [0.45 UI to 0.55 UI] for the UI of the last 0 bit ~~in a string of four 0 bits~~. The number of samples in a histogram (n) for the UI shall be greater than or equal to 100 and shall meet the requirement that:

$$1\,537\,(s / \bar{x})^2 \leq n$$

where:

$\bar{x}$ = the mean of the voltage samples in the histogram that may be read from the HBWS in histogram measurement mode

s = the standard deviation of the voltage samples in the histogram that may also be read from the HBWS

n = the number of samples that contribute to the histogram – this may also be read from the HBWS

Call the mean,

$$D = \bar{x}$$

Step 5, from A, B, C, and D obtained in steps 1 through 4, compute:

$$V_{Emphasis} = 20\log[(A - B)/(C - D)]$$

The test for minimum device emphasis is passed if:

$$V_{Emphasis} \geq V_{EmphasisDevice}(Min)$$

The test for maximum device emphasis is passed if:

$$V_{Emphasis} \leq V_{EmphasisDevice}(Max)$$

The test for minimum host emphasis is passed if:

$$V_{Emphasis} \geq V_{EmphasisHost}(Min)$$

The test for maximum host emphasis is passed if:

$$V_{Emphasis} \leq V_{EmphasisHost}(Max)$$

See Table 54 and Table 55, according to 7.4.2 for $V_{EmphasisDevice}$ and $V_{EmphasisHost}$, otherwise the test for emphasis has not been passed.