



Maxtor Corporation
500 McCarthy Boulevard
Milpitas, CA 95035 USA

To: T10 Serial Attached SCSI PHY Working Group
From: Russ Brown
Email: russ_brown@maxtor.com
Contact: Mark Evans
Email: mark_evans@maxtor.com
408-894-5310
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Subject: Proposed changes for SAS driver and receiver electrical characteristics

Introduction

The following discusses some issues that have been identified with specifications for several items in subclause 5.7 Driver and receiver electrical characteristics, and proposes solutions for each.

Table 15. Transmitted signal characteristics at Tx compliance points

- The transmitted signal “rise/fall times” should be specified from “20% to 80%”.
- The measurement bandwidth of 1.8x baud rate in note f is not sufficient to resolve the minimum rise/fall time limits:

e.g.: @ 3 Gbps:

- scope with BW = 1.8 x 3 Gbps -> 5.4 GHz would have
- 10-90% trise ~ 0.35/5.4 G -> 65 ps or
- 20-80% trise ~ 0.22/5.4 G -> 41 ps.
- This bandwidth is not adequate to resolve a 67 ps min 20% – 80% trise/fall limit.

To resolve these issues we recommend that note f be changed to read, “Rise/fall times are measured from 20% to 80% settled amplitudes using a test load as in figure 29. Measured values are to be corrected for measurement instrument bandwidth and loading.”

Table 19. Impedance requirements

- The TDR rise time for 3 Gbps should be specified from “10% to 90%”.
- Is 85 ps fast enough for TDR rise time at 3 Gbps with 67 ps 20-80% Trise? Shouldn't this be 50 ps?
- Is a specification for “Through connection” needed, since other parameters are defined as measured through mated connector pairs? If it is needed, it should be defined as “Mated connector pairs”.
- We think it would be more clear if the table were divided into sections for “media”, “receiver termination”, and “transmitter source termination”.
- Transmitter source impedance requirements:
 - SAS includes a transmitter source termination specification as in SATA.
 - This is NOT specified in FC. What is in XAUI ? Infiniband?

- A tight transmitter Rsource requirement can significantly restrict driver circuitry design and is not that valuable.
- A tight receiver termination impedance is more easily achieved.
- The magnitude of receive end errors due to source mis-termination is proportional to the product of source and termination reflection coefficients.
- We propose relaxing the transmitter source termination requirement for SAS to allow much lower source impedance values.

e.g., with the above, worst-case differential reflection coefficients are:

- source $\text{RhoS} = (40 - 110) / 150 = -0.467$
- load $\text{RhoL} = (85 - 110) / 195 = -0.128$
- receive end reflection (settling) error $(0.467 * 0.128) \rightarrow 6\%$ (this is still small and is comparable to NEXT errors)
- In note f: the “150 ps” allowed area for the receiver impedance dip corresponds to a 1 GHz pole (3 pf excess capacitance) in the receive path frequency response, and excessive high frequency attenuation for SAS (e.g., at 3 Gbps, -4.8 dB at $[(\text{data rate}) / 2] = 1.5 \text{ GHz}$). We propose specifying an excess differential input capacitance to correspond with an allowed 1 dB max frequency response roll-off at $[(\text{data rate}) / 2]$, to be measured by TDR techniques as described in note f.

To resolve the above the following is the recommended replacement for Table 19:

Parameter	Units	1.5 Gbps	3 Gbps
TDR rise time 10% - 90% ^{a,b}	ps	85	50
Media (PCB or cable)			
Differential impedance ^{b,c,d}	ohms	100 +/- 10	100 +/- 10
Differential impedance match ^{b,c,d}	ohms	+/- 5	+/- 5
Common mode impedance ^{b,c,d}	ohms	32.5 +/- 7.5	32.5 +/- 7.5
Receiver termination			
Differential impedance ^{b,e,f}	ohms	100 +/- 15	100 +/- 15
Differential impedance match ^{b,e,f}	ohms	+/- 5	+/- 5
Excess differential input capacitance ^{b,e,f}	pf	2 max	1 max
Common mode impedance ^{b,e}	ohms	20 min / 40 max	20 min / 40 max
Transmitter source termination			
Differential impedance ^b	ohms	40 min / 115 max	40 min / 115 max
Differential impedance match ^b	ohms	+/- 10	+/- 10
Common mode impedance ^b	ohms	10 min / 40 max	10 min / 40 max

- In note f: because of the above, delete the second-to-last sentence, “The product calculated by this method shall not be greater than 150 ps.”
- Also in note f: in the third-to-last sentence, delete the superscript “a” on “width^a” because it does not apply.

Figure 29. Test loads

- Probe points are shown only at the receiver. These are fine for the receiver, but should also be shown for the transmitter at the compliance point connector.
- A max loading due to measurement probe capacitance of ?? 0.5 pf ?? (50 ohms x 0.5 pf -> 25 ps) should also be specified.