T10/08-433r0
SAS_PHY: Comments on sas2r14g

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Overview

- Rise/Fall Measurements – should we perform with D24.3 instead of D10.2?
- Transmitter device characteristics for trained devices should mention RJ and TJ specs to include the JTF.
- Incorrect S parameter graphs vs. Table
  - Even though it says “Not to scale” the curve should fit
  - Comparison with the reference models also have this issue.
- Specify clearly that jitter tolerance test for trained receivers must be done without SSC
  - Could be a cause of confusion
  - The SJ curve accounts for it
- Other miscellaneous corrections

Rise/Fall Measurement Pattern

- Currently D10.2 is specified (1010...)
- This may not allow the data to settle
  - Will change the 20%-80% reference
- D24.3 should be sufficient as this is measured near-end
- Tables 57, 59, and 63 should be changed

Table 59 — Transmitter device signal output characteristics for trained 1.5 Gbps, 3 Gbps, and 6 Gbps at IT and CT

Signal characteristic	Units	Minimum	Nominal	Maximum
Rise/fall time [c]	UI	0.25 [d]		

[c] Rise/fall times are measured from 20 % to 80 % of the transition with a repeating ~~01b or 10b~~ pattern (e.g., D~~10.2 or D21~~.5)(see table 241 in 10.2.9.2) on the physical link.

0011b

D24.3

Trained Transmitter vs. JTF

- There is no mention that the JTF has to be used for the latest TJ and TJ-DDJ specs in Table 59

Table 59 — Transmitter device signal output characteristics for trained 1.5 Gbps, 3 Gbps, and 6 Gbps at IT and CT

Signal characteristic	Units	Minimum	Nominal	Maximum
RJ [g, j]	UI			0.15 [k]
TJ [g, h, j]	UI			0.25 [d]
TJ - DDJ [g, i, j]	UI			0.25 [d]

[j] The measurement shall include the effects of the JTF (see 5.7.3.2).

Incorrect S parameter Graphs

- The graphs of the S-parameters Spec. have incorrect high-frequency asymptote for S_{CD22} parameter
- Figures 131, 133, 136 and 138
- Furthermore, the paragraph before Figure 133 refers to the wrong figure.

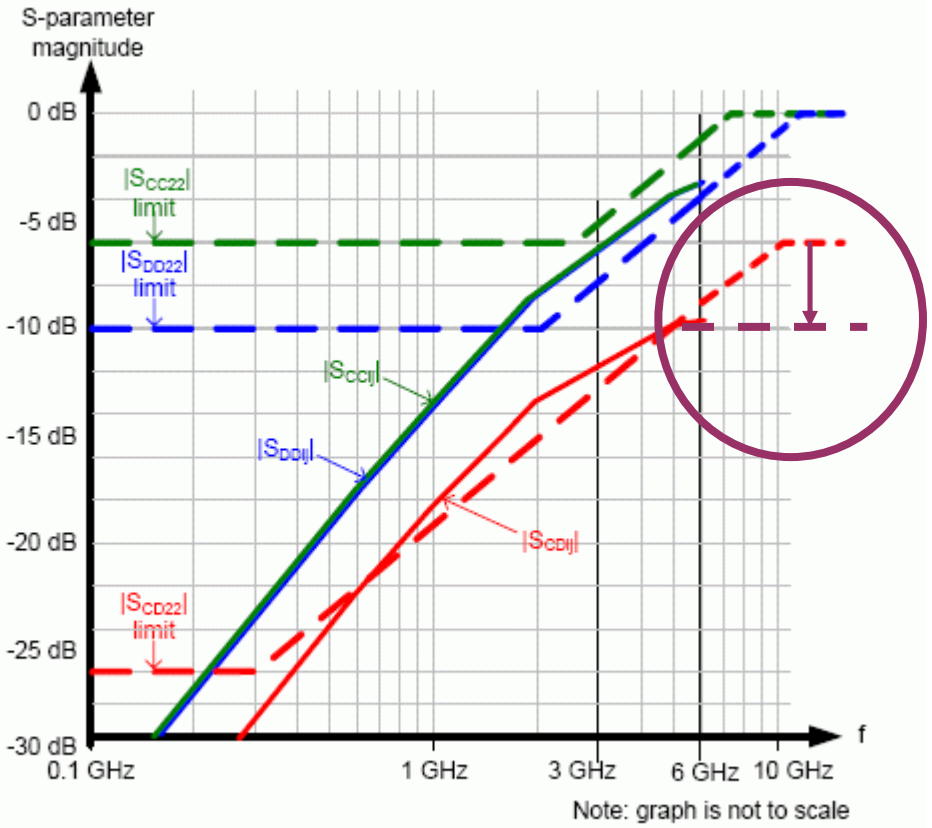
Table 61 — Maximum limits for S-parameters at IT_s or CT_s

Characteristic [a, b]	L [c] (dB)	N [c] (dB)	H [c] (dB)	S [c] (dB / decade)	f_{min} [c] (MHz)	f_{max} [c] (GHz)
$\lvert S_{CC22} \rvert$	-6.0	-5.0	0	13.3	100	6.0
$\lvert S_{DD22} \rvert$	-10	-7.9	0	13.3	100	6.0
$\lvert S_{CD22} \rvert$	-26	-12.7	-10	13.3	100	6.0

[a] For S-parameter measurements, the transmitter device under test shall transmit a repeating 0011b or 1100b pattern (e.g., D24.3)(see table 241 in 10.2.9.2). The amplitude applied by the test equipment shall be less than -4.4 dBm (190 mV zero to peak) per port. See D.9.4.2.
[b] $\lvert S_{DC22} \rvert$ is not specified.
[c] See figure 57 in 5.2 for definitions of L, N, H, S, f_{min}, and f_{max}.

Incorrect S parameter Graphs

Figure 138 shows the S-parameters of the reference transmitter device termination model.



-6 dB

-10 dB

Figure 133 – Reference transmitter device termination S-parameters

Specify to run the trained JT tests without SSC

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- Nowhere does it say to run it with SSC, but it could be confusing
  - I suggest to explain the rationale to do so at the same time
- Although it is specified in 5.7.3.5, 5.7.5.5 and 5.7.5.6, I also suggest to say that section 5.7.5.7.4 only applies to trained receivers
  - Specifying that the JTF shall not be applied to the SJ does not hurt (as a contrast to Tx RJ). But this could be seen as superfluous.

Specify to run the trained JT tests without SSC

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5.7.5.7.4.1 Stressed receiver device jitter tolerance test overview

that supports trained 1.5 Gbs, 3Gbs or 6 Gbs

A receiver device shall pass the stressed receiver device jitter tolerance test described in this subclause. The receiver device under test shall have a BER that is less than 10^{-12} with a confidence level of 95 % when subjected to the additional SJ defined in 5.7.5.7.4.4. The BER is computed on the raw bit stream before 8b10b decoding.

Note that the jitter tolerance test shall be done without any SSC in the input data. A more stringent SJ profile has to be applied to receivers that support SSC.

Table 74 — Stressed receiver device jitter tolerance test characteristics

Characteristic	Units	Minimum	Nominal	Maximum	Reference
Tx SJ [c], [q]	UI	See figure 141 and figure 142			5.7.5.7.4.4

[q] The calibration of the SJ shall be done without the JTF.

Miscellaneous: Cleanup of mask definitions

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- Figures 127, 128 and 129 have no specification for trained interconnects
  - This is a consequence of WDP now being used
  - Should we keep the paragraphs that refer to simulations since there is no spec for X1, X2, Z1 nor Z2 in these cases?
    - The idea after specifying WDP is that this method could still be used even if no software to perform this was suggested, but now even the specs. have disappeared from the tables.
  - 5.7.3.4 was fixed, 5.7.3.3 partly fixed from rev. f.
- 5.7.3.1:

~~For trained 1.5 Gbps, 3 Gbps, and 6 Gbps, simulations are used to approximate the eye diagram after application of receiver equalization, instead of direct measurements of the signal at the IR and CR compliance points.~~

- 5.7.3.3 (was partly fixed already from rev. f)

5.7.3.3 Transmitter device eye mask for untrained 1.5 Gbps and 3 Gbps

Figure 127 describes the eye mask used for testing the signal output of the transmitter device at IT, CT, ~~IR, and CR~~ for untrained 1.5 Gbps and 3 Gbps (see ~~table 57 in 5.7.4.4 and~~ table 58 in 5.7.4.5) and OOB signals (see table 64 in 5.7.4.7).

Miscellaneous: Jitter setup vs. SSC for untrained jitter tolerance

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- Note d in Table 67 should specify using the JTF when SSC is supported
  - Also applies to 5.7.3.5

[c] SSC shall be enabled if supported by the receiver device. SSC shall not be enabled if the receiver device does not support SSC. The SSC type should be the same as that applied to the receiver device during normal operation. Multiple tests may be required depending on if the receiver device supports being attached to SATA or supports SSC. Jitter setup shall be performed prior to application of SSC.

[d] The value for X1 shall be half the value given for TJ in table 68. When SSC is disabled, the test or analysis shall include the effects of a single pole high-pass frequency-weighting function that progressively attenuates jitter at 20 dB/decade below a frequency of (f_{baud} / 1 667).

When SSC is supported, the JTF should be used.

Miscellaneous: Jitter setup vs. SSC for untrained jitter tolerance

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- Should Table 69 (and 5.7.3.5) specify that the calibration of the DJ and TJ be done without SSC (and with JTF or other filter?)
  - Currently only at the end of note c in Table 67.

c SSC shall be enabled if supported by the receiver device. SSC shall not be enabled if the receiver device does not support SSC. The SSC type should be the same as that applied to the receiver device during normal operation. Multiple tests may be required depending on if the receiver device supports being attached to SATA or supports SSC. Jitter setup shall be performed prior to application of SSC.

Table 69 — Receiver device jitter tolerance for untrained 1.5 Gbps and 3 Gbps at IR and CR

Signal characteristic	Units	Untrained	
		1.5 Gbps	3 Gbps
Applied sinusoidal jitter (SJ) from f_c to f_{max} [a]	UI	0.10 [e]	0.10 [f]
Deterministic jitter (DJ) [b, c]	UI	0.35 [g]	0.35 [h]
Total jitter (TJ) [b, c, d]	UI	0.65	

[a] The jitter values given are normative for a combination of applied SJ, DJ, and TJ that receiver devices shall be able to tolerate without exceeding the required BER (see 5.5.1). Receiver devices shall tolerate applied SJ of progressively greater amplitude at lower frequencies than f_c, according to figure 135, with the same DJ and RJ levels as were used from f_c to f_{max}.
[b] All DJ and TJ values are level 1 (see MJSQ).
[c] The DJ and TJ values in this table apply to jitter measured as described in 5.7.3.4. Values for DJ and TJ shall be calculated from the CDF for the jitter population using the calculation of level 1 jitter compliance levels method in MJSQ.
[d] No value is given for RJ. For compliance with this standard, the actual RJ amplitude shall be the value that brings TJ to the stated value at a probability of 10^{-12}. The additional 0.1 UI of applied SJ is added to ensure the receiver device has sufficient operating margin in the presence of external interference.
[e] Applied sinusoidal swept frequency for 1.5 Gbps: 900 kHz to 5 MHz.
[f] Applied sinusoidal swept frequency for 3 Gbps: 1 800 kHz to 7.5 MHz.
[g] The measurement bandwidth for 1.5 Gbps shall be 900 kHz to 750 MHz.
[h] The measurement bandwidth for 3 Gbps shall be 1 800 kHz to 1 500 MHz.

Miscellaneous: Reference Receiver

- Par. 5.7.5.7.3 does not apply to TX compliance
  - now WDP

5.7.5.7.3 Reference receiver device characteristics

The reference receiver device is a set of parameters defining the electrical performance characteristics of a receiver device used in simulation to:

~~a) determine compliance of a transmitter device (see 5.7.4.6); and~~
b) determine compliance of a TxRx connection (see 5.5.5).

Miscellaneous: fc rounding

- Tables 70 and 75 should round the fc spec.
  - Really this is fbaud/1666.666...
  - Inconsistent with other specs. of 900 kHz and 1800 kHz (e.g. notes in table 69)

Table 75 — f_{min}, f_c, f_{max}, and f_{nom} for trained 1.5 Gbps, 3 Gbps, and 6 Gbps without SSC support

Physical link rate	f_{min}	f_c	f_{max}	f_{nom}
1.5 Gbps	60 kHz	889.82 kHz	5 MHz	1.5 GHz
3 Gbps	120 kHz	1 799.64 kHz	7.5 MHz	3 GHz
6 Gbps	240 kHz	3 599.28 kHz	15 MHz	6 GHz

Miscellaneous: Wrong (or missing) reference to SASWDP procedure

- Par. 5.7.5.7.4.2 has a broken reference to WDP procedure
  - Either write a new 5.7.5.7.4.3, or refer to 5.7.4.6.2
- Also WDP is defined as a range

The captured waveform shall be processed as described in section 5.7.5.7.4.3 to determine the WDP. An ISI generator suitable for this test shall have:

within the range

a) a WDP ~~greater than that~~ defined in table 74; and
b) an $|S_{DD21}|$ comparable to that of the reference transmitter test load (see 5.6.5).

5.7.5.7.4.3 Crosstalk source calibration

A coupling mechanism is used to inject representative crosstalk to the receiver device under test at the IR or CR. The center frequency of the crosstalk source shall be frequency offset from the pattern generator to

Miscellaneous: fbaud vs. fnom & typo

- Both f_{nom} and f_{baud} are used throughout the spec.
- f_{baud} is more-or-less defined in 3.1.18, but not f_{nom}
  - Should standardize to f_{baud}
- Table 82 typo

Table 82 — Expander device center-spreading tolerance buffer

Physical link rate	Minimum buffer size
6 Gbps	14 dwords
3 Gbps	8 dwords
1.5 Gbps	4 dwords

be

NOTE 35 - The minimum buffer size is based on the number of dwords that may transmitted during half of the longest allowed SSC modulation period (i.e., half of the period indicated by 30 kHz) at the maximum physical link rate (i.e., +2 400 ppm) minus the number that may be transmitted at the minimum physical link rate (i.e., -2 400 ppm). This accounts for forwarding dwords in a connection that originated from a phy compliant with previous versions of this standard (i.e., a phy with an SSC modulation type of no-spreading and inserting deletable primitives at a rate supporting only the long-term frequency stability).

Miscellaneous: BER definition

- There should be a general paragraph that says that all BERs are to be measured on the raw data, before the 8b10b decoding
- This is specified in 5.7.5.7.4.1, but should be in 3.1.21
  - Then it could be removed from 5.7.5.7.4.1, or left as is

5.7.5.7.4.1 Stressed receiver device jitter tolerance test overview

A receiver device shall pass the stressed receiver device jitter tolerance test described in this subclause. The receiver device under test shall have a BER that is less than 10^{-12} with a confidence level of 95 % when subjected to the additional SJ defined in 5.7.5.7.4.4. The BER is computed on the raw bit stream before 8b10b decoding.

3.1.21 bit error ratio (BER): The number of logical bits output from a receiver circuit that differ from the correct transmitted logical bits, divided by the number of transmitted logical bits. The BER is usually expressed as a coefficient and a power of 10 (e.g., 2 erroneous bits out of 100 000 bits transmitted is expressed as 2 out of 10^5 or 2×10^{-5}). See MJSQ.

Unless otherwise noted, the BER is always computed on the raw bit stream, before the 8b10b decoding.