# USB 3.1 ENGINEERING CHANGE NOTICE

## Title: SSP System Jitter Budget
## Applied to: USB_3_1r1.0_07_31_2013

| Brief description of the functional changes: |
|---|
| Change to the 10Gbps system jitter budget. The change reduces the random jitter (RJ) budget for both transmitters and receivers from 18.4ps to 14.1ps each, and gives 6.1ps relief to the receiver deterministic jitter (DJ) budget. |

| Benefits as a result of the changes: |
|---|
| Reduces the design difficulty for SuperSpeed Gen 2 receivers by giving them more budget for deterministic jitter. The reduction in RJ is based upon comparison with other industry specs. For example, the jitter spec for PCIe4 and 10G KR are closer to 1ps RMS @ 1e-12BER. This ECR proposes to reduce the RJ budget from 18.4ps to 14.1ps at 1e-12BER (1.00ps RMS), which is consistent with those specs. |

| An assessment of the impact to the existing revision and systems that currently conform to the USB specification: |
|---|
| No existing systems exist. |

| An analysis of the hardware implications: |
|---|
| No existing products on the market. While this proposal is intended to make Gen 2 receivers easier to design, we acknowledge that there is potential impact to in-progress designs. The PHY development companies represented in the PHY WG (Intel, AMD, Synopsys) all support this change, recognizing the benefit to their design efforts. |

| An analysis of the software implications: |
|---|
| None |

| An analysis of the compliance testing implications: |
|---|
| The proposal results in changes to the Gen 2 eye mask for transmitter compliance and to the random jitter input for receiver jitter tolerance testing. Since the Gen 2 compliance program is not yet in place, these impacts are minimal as they will be incorporated into the CTS as we develop it. |

# USB 3.1 ENGINEERING CHANGE NOTICE

## Actual Change

### (a). From, in section 6.5.1, table 6-15, page 6-22

**Table 6-1. Informative Jitter Budgeting at the Silicon Pads**

| Jitter Contribution (ps) | Gen 1 (5 GT/s) | | | Gen 2 (10 GT/s) | | |
|---|---|---|---|---|---|---|
| | Rj[1,2] | Dj[3] | Tj[4] at $10^{-12}$ | Rj[1,2] | Dj[3] | Tj[4] at $10^{-12}$ |
| Tx[6] | 2.42 | 41 | 75 | 1.31 | 17 | 35.4 |
| Media[5] | 2.13 | 45 | 75 | 0.00 | 36 | 36.0 |
| Rx | 2.42 | 57 | 91 | 1.31 | 21 | 39.4 |
| Total: | 4.03 | 143 | 200 | 1.85 | 74 | 100 |

Notes:

1. Rj is the sigma value assuming a Gaussian distribution.
2. Rj Total is computed as the Root Sum Square of the individual Rj components.
3. Dj budget is using the Dual Dirac method.
4. Tj at a $10^{-12}$ BER is calculated as 14.068 * Rj + Dj.
5. The media budget includes the cancellation of ISI from the appropriate Rx equalization function.
6. Tx is measured after application of the JTF.

### (a). To, in section 6.5.1, table 6-16, page 6-22

**Table 6-2. Informative Jitter Budgeting at the Silicon Pads**

| Jitter Contribution (ps) | Gen 1 (5 GT/s) | | | Gen 2 (10 GT/s) | | |
|---|---|---|---|---|---|---|
| | Rj[1,2] | Dj[3] | Tj[4] at $10^{-12}$ | Rj[1,2] | Dj[3] | Tj[4] at $10^{-12}$ |
| Tx[6] | 2.42 | 41 | 75 | 1.00 | 17 | 31.1 |
| Media[5] | 2.13 | 45 | 75 | 0.00 | 36 | 36.0 |
| Rx | 2.42 | 57 | 91 | 1.00 | 27.1 | 41.2 |
| Total: | 4.03 | 143 | 200 | 1.41 | 80.1 | 100 |

Notes:

7. Rj is the sigma value assuming a Gaussian distribution.
8. Rj Total is computed as the Root Sum Square of the individual Rj components.
9. Dj budget is using the Dual Dirac method.
10. Tj at a $10^{-12}$ BER is calculated as 14.068 * Rj + Dj.
11. The media budget includes the cancellation of ISI from the appropriate Rx equalization function.
12. Tx is measured after application of the JTF.

## (b). From, in section 6.7.3, table 6-19, page 6-32

**Table 6-3. Normative Transmitter Eye Mask at Test Point TP1**

| | 5GT/s | | | 10GT/s | | | | |
|---|---|---|---|---|---|---|---|---|
| **Signal Characteristic** | **Minimum** | **Nominal** | **Maximum** | **Minimum** | **Nominal** | **Maximum** | **Units** | **Note** |
| Eye Height | 100 | | 1200 | 70 | | 1200 | mV | 2,4 |
| Dj | | | 0.43 | | | 0.530 | UI | 1,2,3 |
| Rj | | | 0.23 | | | 0.184 | UI | 1,2,3,5 |
| Tj | | | 0.66 | | | 0.714 | UI | 1,2,3 |

Notes:

1. Measured over $10^6$ consecutive UI and extrapolated to $10^{-12}$ BER.
2. Measured after receiver equalization function.
3. Measured at end of reference channel and cables at TP1 in Figure 6-19.
4. The eye height is to be measured at the minimum opening over the range from the center of the eye ± 0.05 UI.
5. The Rj specification is calculated as 14.069 times the RMS random jitter for $10^{-12}$ BER.

## (b). To, in section 6.7.3, table 6-19, page 6-32

**Table 6-4. Normative Transmitter Eye Mask at Test Point TP1**

| | 5GT/s | | | 10GT/s | | | | |
|---|---|---|---|---|---|---|---|---|
| **Signal Characteristic** | **Minimum** | **Nominal** | **Maximum** | **Minimum** | **Nominal** | **Maximum** | **Units** | **Note** |
| Eye Height | 100 | | 1200 | 70 | | 1200 | mV | 2,4 |
| Dj | | | 0.43 | | | 0.530 | UI | 1,2,3 |
| Rj | | | 0.23 | | | 0.141 | UI | 1,2,3,5 |
| Tj | | | 0.66 | | | 0.671 | UI | 1,2,3 |

Notes:

1. Measured over $10^6$ consecutive UI and extrapolated to $10^{-12}$ BER.
2. Measured after receiver equalization function.
3. Measured at end of reference channel and cables at TP1 in Figure 6-19.
4. The eye height is to be measured at the minimum opening over the range from the center of the eye ± 0.05 UI.
5. The Rj specification is calculated as 14.069 times the RMS random jitter for $10^{-12}$ BER.

## (c). From, in section 6.8.5, table 6-27, page 6-43

**Table 6-5. Input Jitter Requirements for Rx Tolerance Testing**

| Symbol | Parameter | Gen 1 (5GT/s) | Gen 2 (10GT/s) | Units | Notes |
|---|---|---|---|---|---|
| f1 | Tolerance corner | 4.9 | 7.5 | MHz | |
| $J_{Rj}$ | Random Jitter | 0.0121 | 0.01308 | UI rms | 1 |
| $J_{Rj\_p\text{-}p}$ | Random Jitter peak- peak at $10^{-12}$ | 0.17 | 0.184 | UI p-p | 1,4 |
| $J_{Pj\_500kHZ}$ | Sinusoidal Jitter | 2 | 4.76 | UI p-p | 1,2,3 |
| $J_{Pj\_1Mhz}$ | Sinusoidal Jitter | 1 | 2.03 | UI p-p | 1,2,3 |
| $J_{Pj\_2MHz}$ | Sinusoidal Jitter | 0.5 | 0.87 | UI p-p | 1,2,3 |
| $J_{Pj\_4MHz}$ | Sinusoidal Jitter | N/A | 0.37 | UI p-p | 1,2,3 |
| $J_{Pj\_f1}$ | Sinusoidal Jitter | 0.2 | 0.17 | UI p-p | 1,2,3 |
| $J_{Pj\_50MHz}$ | Sinusoidal Jitter | 0.2 | 0.17 | UI p-p | 1,2,3 |
| $J_{Pj\_100MHz}$ | Sinusoidal Jitter | N/A | 0.17 | UI p-p | 1,2,3 |
| V_full_swing | Transition bit differential voltage swing | 0.75 | 0.8 | V p-p | 1 |
| V_EQ_level | Non transition bit voltage (equalization) | -3 | Preshoot=2.7<br>De-emphasis= -3.3 | dB | 1 |

Notes:

1. All parameters measured at TP1. The test point is shown in Figure 6-19.
2. Due to time limitations at compliance testing, only a subset of frequencies can be tested. However, the Rx is required to tolerate Pj at all frequencies between the compliance test points.
3. During the Rx tolerance test, SSC is generated by test equipment and present at all times. Each $J_{Pj}$ source is then added and tested to the specification limit one at a time.
4. Random jitter is also present during the Rx tolerance test, though it is not shown in Figure 6-20.
5. The JTOL specs for Gen 2 comprehend jitter peaking with re-timers in the system and has a 25dB/decade slope.

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## (b). To, in section 6.8.5, table 6-27, page 6-43

**Table 6-6. Input Jitter Requirements for Rx Tolerance Testing**

| Symbol | Parameter | Gen 1 (5GT/s) | Gen 2 (10GT/s) | Units | Notes |
|---|---|---|---|---|---|
| f1 | Tolerance corner | 4.9 | 7.5 | MHz | |
| $J_{Rj}$ | Random Jitter | 0.0121 | 0.0100 | UI rms | 1 |
| $J_{Rj\_p\text{-}p}$ | Random Jitter peak- peak at $10^{-12}$ | 0.17 | 0.184 | UI p-p | 1,4 |
| $J_{Pj\_500kHZ}$ | Sinusoidal Jitter | 2 | 4.76 | UI p-p | 1,2,3 |
| $J_{Pj\_1Mhz}$ | Sinusoidal Jitter | 1 | 2.03 | UI p-p | 1,2,3 |
| $J_{Pj\_2MHz}$ | Sinusoidal Jitter | 0.5 | 0.87 | UI p-p | 1,2,3 |
| $J_{Pj\_4MHz}$ | Sinusoidal Jitter | N/A | 0.37 | UI p-p | 1,2,3 |
| $J_{Pj\_f1}$ | Sinusoidal Jitter | 0.2 | 0.17 | UI p-p | 1,2,3 |
| $J_{Pj\_50MHz}$ | Sinusoidal Jitter | 0.2 | 0.17 | UI p-p | 1,2,3 |

| | | | | | |
|---|---|---|---|---|---|
| $J_{Pj\_100MHz}$ | Sinusoidal Jitter | N/A | 0.17 | UI p-p | 1,2,3 |
| V_full_swing | Transition bit differential voltage swing | 0.75 | 0.8 | V p-p | 1 |
| V_EQ_level | Non transition bit voltage (equalization) | -3 | Preshoot=2.7<br>De-emphasis= -3.3 | dB | 1 |

Notes:

1. All parameters measured at TP1. The test point is shown in Figure 6-19.
2. Due to time limitations at compliance testing, only a subset of frequencies can be tested. However, the Rx is required to tolerate Pj at all frequencies between the compliance test points.
3. During the Rx tolerance test, SSC is generated by test equipment and present at all times. Each $J_{Pj}$ source is then added and tested to the specification limit one at a time.
4. Random jitter is also present during the Rx tolerance test, though it is not shown in Figure 6-20.
5. The JTOL specs for Gen 2 comprehend jitter peaking with re-timers in the system and has a 25dB/decade slope.