USB Type-C ENGINEERING CHANGE NOTICE

Title: IDDXT C to C Assembly
Applied to: Universal Serial Bus Type-C Cable and Connector Specification Release 1.1, April 3, 2015

Brief description of the functional changes:
The requirement of the Integrated differential SuperSpeed crosstalk on D+/D- (IDDXT) was partially defined for USB Type C to USB3.1 Gen 2 legacy cable assemblies and USB Type C to USB 3.1 standard-A receptacle adapter assemblies. Since there is only 1 SuperSpeed port in these cable assemblies, the IDDXT has only accounted for 1 differential far-end xtalk (FEXT) and 1 differential near-end xtalk (NEXT). For 1m and 2m USB Type-C to Type-C passive cable assemblies, the worst case xtalk scenario occurs in the Alt Mode in which D+/D- signal may receive the coupling noise from 4 high frequency differential pairs and 2 low speed SBU wires. After accounting for the SBU to D+/D- noise limit defined in Type C Spec 1.1 Table 5-3, this ECR proposes to limit the crosstalk from the 2 SuperSpeed differential pairs to D+/D−.

Benefits as a result of the changes:
Ensure robustness of USB2.0 link quality in all Type-C cable usages.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:
No impact on Type C connectors and raw cables since the connector pinout ensures low crosstalk between D+/D- and high speed pairs. The paddle card, if designed poorly, could introduce excessive crosstalk. Spot check of existing Type-C cables suggests typical paddle card designs can easily meet the proposed IDDXT spec limit.

An analysis of the hardware implications:
N/A

An analysis of the software implications:
N/A

An analysis of the compliance testing implications:
The proposal results in adding the new measurement item and pass criteria to 1m and 2m USB Type-C to Type-C passive cable assemblies in the cable compliance testing tool which processes the measured cable s parameters.

Actual Change

(a). Section 3.7.3.2.3, Page 80

From:

3.7.3.2.3 Integrated Crosstalk between SuperSpeed Pairs (Normative)

The integrated crosstalk between all USB SuperSpeed pairs is calculated with the equations below:

$$INEXT = dB\left(\sqrt{\frac{\int_0^{f_{max}} |Vin(f)|^2 (|NEXT(f)|^2 + 0.125^2 \cdot |C2D(f)|^2) df + |Vdd(f)|^2 \, |NEXTd(f)|^2 df}{\int_0^{f_{max}} |Vin(f)|^2 df}}\right)$$

$$IFEXT = dB\left(\sqrt{\frac{\int_0^{f_{max}} |Vin(f)|^2 (|FEXT(f)|^2 + 0.125^2 \cdot |C2D(f)|^2) df + |Vdd(f)|^2 \, |FEXTd(f)|^2 df}{\int_0^{f_{max}} |Vin(f)|^2 df}}\right)$$

where *NEXT(f)*, *FEXT(f)*, and *C2D(f)* are the measured near-end and far-end crosstalk between USB SuperSpeed pairs, and the common-mode-to-differential conversion, respectively. The factor of 0.125^2 accounts for the assumption that the common mode amplitude is 12.5% of the differential amplitude. *NEXTd(f)* and *FEXTd(f)* are, respectively, the near-end and far-end crosstalk from the D+/D- pair to SuperSpeed pairs. *Vdd(f)* is the input pulse spectrum evaluated using the equation in **Error! Reference source not found.** with Tb=2.08 ns.

The integration shall be done for each NEXT and FEXT between USB SuperSpeed pairs located at A2, A3 to B10, B11 and B2, B3 to A10, A11 (See **Error! Reference source not found.**). Coupling between other combinations of USB SuperSpeed pairs is comparatively lower. The largest values of INEXT and IFEXT shall meet the following requirements:

- INEXT ≤ −40 dB,
- IFEXT ≤ −40 dB.

To:

3.7.3.2.3 Integrated Crosstalk (Normative)

The integrated crosstalk between all USB SuperSpeed pairs is calculated with the following equations ~~below~~:

$$INEXT = dB\left(\sqrt{\frac{\int_0^{fmax}|Vin(f)|^2(|NEXT(f)|^2 + 0.125^2 \cdot |C2D(f)|^2)df + |Vdd(f)|^2\,|NEXTd(f)|^2 df}{\int_0^{fmax}|Vin(f)|^2 df}}\right)$$

$$IFEXT = dB\left(\sqrt{\frac{\int_0^{fmax}|Vin(f)|^2(|FEXT(f)|^2 + 0.125^2 \cdot |C2D(f)|^2)df + |Vdd(f)|^2\,|FEXTd(f)|^2 df}{\int_0^{fmax}|Vin(f)|^2 df}}\right)$$

where *NEXT(f)*, *FEXT(f)*, and *C2D(f)* are the measured near-end and far-end crosstalk between USB SuperSpeed pairs, and the common-mode-to-differential conversion, respectively. The factor of 0.125^2 accounts for the assumption that the common mode amplitude is 12.5% of the differential amplitude. *NEXTd(f)* and *FEXTd(f)* are, respectively, the near-end and far-end crosstalk from the D+/D- pair to SuperSpeed pairs. *Vdd(f)* is the input pulse spectrum evaluated using the equation in **Error! Reference source not found.** with Tb=2.08 ns.

The integration shall be done for each NEXT and FEXT between USB SuperSpeed pairs located at A2, A3 to B10, B11 and B2, B3 to A10, A11 (See **Error! Reference source not found.**). Coupling between other combinations of USB SuperSpeed pairs is comparatively lower. The largest values of INEXT and IFEXT shall meet the following requirements:

- INEXT ≤ −40 dB,
- IFEXT ≤ −40 dB.

Crosstalk from the SuperSpeed pairs to USB 2.0 D+/D- shall be controlled to ensure the robustness of the USB 2.0 link. Since USB Type-C to Type-C Full-Featured cable assemblies may support the usage of SuperSpeed or an alternate mode (e.g., DisplayPort), the crosstalk from the four high speed differential pairs to D+/D- may be from near-end crosstalk, far-end crosstalk, or a combination of the two. The integrated crosstalk to D+/D- is calculated with the following equations:

$$\text{IDDXT\_1NEXT + FEXT} = dB\left(\sqrt{\frac{\int_0^{f_{max}}|Vin(f)|^2(|NEXT1(f)|^2 + |Vin(f)|^2\,|FEXT(f)|^2 df}{\int_0^{f_{max}}|Vin(f)|^2 df}}\right)$$

where:
NEXT = Near-end crosstalk from SuperSpeed Tx pair to D+/D−
FEXT = Far-end crosstalk from SuperSpeed Rx pair to D+/D−
f_{max} = 1.2 GHz

$$\text{IDDXT\_2NEXT} = dB\left(\sqrt{\frac{\int_0^{f_{max}}|Vin(f)|^2(|NEXT1(f)|^2 + |Vin(f)|^2\,|NEXT2(f)|^2 df}{\int_0^{f_{max}}|Vin(f)|^2 df}}\right)$$

where:
NEXT1 = Near-end crosstalk from SuperSpeed Tx pair to D+/D−
NEXT2 = Near-end crosstalk from SuperSpeed Rx (the Rx functioning in a Tx mode) pair to D+/D−
f_{max} = 1.2 GHz

The integration shall be done for NEXT + FEXT and 2NEXT on D+/D- from the two differential pairs located at A2, A3, B10 and B11 (See **Error! Reference source not found.**) and for NEXT + FEXT and 2NEXT on D+/D- from the two differential pairs located at B2, B3 A10 and A11 (See **Error! Reference source not found.**). Measurements are made in two sets to minimize the number of ports required for each measurement. The integrated differential crosstalk on D+/D- shall meet the following requirements:

- $I_{DDXT\_1NEXT+FEXT} \leq -34.5$ dB
- $I_{DDXT\_2NEXT} \leq -33$ dB