USB Type-C ENGINEERING CHANGE NOTICE FORM

Title: V_{BUS} Coupling
Applied to: USB Type-C Specification Release 1.2

Brief description of the functional changes:

V_{BUS} inductance induced noise = M* di/dt

- di/dt is well defined as iLoadStepRate in USB PD spec
- Mutual inductance between two conductors is M = k* square root of (L1*L2)
- K is mutual inductance coupling factor. The maximum value of k is 0.3.
- L1 is V_{BUS} loop inductance. The maximum value of L1 is 900nH.
- L2 is the low speed line loop inductance. The maximum is equal to the max wire impendence (93ohm for CC, 53ohm for SBU_A, SBU_B and 52.5ohm for D+, D-) multiplying by 26ns propagation delay.

The ECN replaces the k spec with the M spec. The maximum values of the mutual inductance between V_{BUS} and other low speed lines based on the current spec are

Wire	K	Delay (ns)	Zo (ohm)	M (nH) (vs. V_{BUS})
V_{BUS}	N/A	L_V_{BUS} = 900 nH		N/A
CC	0.3	26	93	443
D+, D-	0.3	26	52.5	333
SBU	0.3	26	53	334

Benefits as a result of the changes:

Some cables have been seen to violate the existing k factor spec while the loop inductance is far below the maximum values. By replacing the k factor spec with the M spec, larger k factor is allowed if a cable has smaller loop inductance. In other word, larger solution space is allowed for cable design to meet the compliance spec.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:

No negative impact. Those cables compliant to the existing k factor and the loop inductance spec will surely pass the new M spec.

An analysis of the hardware implications:

More flexible cable bundle design will be allowed.

An analysis of the software implications:

None

An analysis of the compliance testing implications:

In order to extract the M and L values properly, new test fixtures with no V_{BUS} bulk capacitors and low V_{BUS} impedance traces are required. The V_{BUS} routings shall be de-embedded to less than 2mm. The cable compliance test tool will need to be changed to calculate the mutual inductance, M, instead of the k factor from the measured S parameters.

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Actual Change

(a). From, Section 3.7.2.3.2, Page 85

The loop inductance of V_{BUS} and its coupling factor to low speed lines is controlled to limit noise induced on low speed signaling lines. The maximum loop inductance of V_{BUS} shall be 900 nH and the maximum mutual inductance coupling factor (k) between V_{BUS} and low speed signal lines (CC, SBU_A, SBU_B, D+, D−) shall be 0.3. For fully featured cables, the range of V_{BUS} bypass capacitance shall be 8nF up to 500nF as any of the values in the range is equally effective for high-speed return-path bypassing.

(a). To, Section 3.7.2.3.2, Page 85

~~The loop inductance of VBUS and its coupling factor to low speed lines is controlled to limit noise induced on low speed signaling lines.~~ The maximum V_{BUS} loop inductance ~~of VBUS~~ shall be 900 nH and the maximum mutual inductance (M) ~~coupling factor (k)~~ between V_{BUS} and low speed signal lines (CC, SBU_A, SBU_B, D+, D−) shall be as specified in Table 3-XX to limit V_{BUS} inductive noise coupling on low speed signal lines~~. shall be 0.3.~~ For fully featured cables, the range of V_{BUS} bypass capacitance shall be 8nF up to 500nF as any of the values in the range is equally effective for high-speed return-path bypassing.

Table 3-XX Maximum Mutual Inductance (M) between V_{BUS} and Low Speed Signal Lines

Low Speed Wire	Max Mutual Inductance (nH)
CC	350
SBU_A, SBU_B	330
D+, D-	330