USB Type-C ENGINEERING CHANGE NOTICE

Title: Low Speed Signal Coupling Requirements Change Applied to: USB Type-C Specification Release 1.0, August 11, 2014

Brief description of the functional changes:

Adjust the minimum frequency (Fmin) to 300KHz from 1MHz in the low speed signal coupling matrices.

Reduce the maximum frequency (Fmax) to 100MHz from 500MHz for single-ended coupling between SBU1/SBU2 and CC and differential coupling between SBU1/SBU2 and USB D+/D- signals.

Replace the s-parameter coupling specs for VBUS-to-CC and VBUS-to-SBU1 and VBUS-to-SBU2 with a mutual inductance term. The following reasons apply: 1) system-side VBUS power spectra for Vbus noise appear to be very much decoupled from cable assembly with host/device systems with decoupling capacitor (>= 0.2uF) in place, 2) and hence cable-side coupling violation will be masked by that. Keep VBUS-to-D+/D- coupling spec in tact as it inherits USB-PD specification.

The mutual inductance term from VBUS to respective victim is needed to bound the VBUS conductor's step current transient on the respective victim signal waveform. The mutual term was bounded by the former s-parameter curve. Since there are circuit resonances that complicate the s-parameter view, an extraction of the mutual term is chosen to model the coupling that independent of the circuit resonance.

For fully featured cables, specify VBUS bypass-capacitance in terms of valid range (10nF up to 500nF) as opposed to a single value (10nF) to allow for design choice. Such range appears effective for high-speed return-path bypassing.

Benefits as a result of the changes:

Fmin to 300KHz will adequately specify the ingress noise to BMC signaling as it runs at 300KHz.

Fmax to 100MHz will alleviate the challenge of cable bundle designs as some of cable vendors have hard time meeting the coupling spec at frequency range higher than 100MHz. Consequently, SBU signals reserved for future usage are required to operate in the frequency less than the revised Fmax.

Effectively a simpler cable model is used for VBUS transient coupling to victim lines.

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

None.

An analysis of the hardware implications:

Allows for more choices for cable bundle designs.

An analysis of the software implications:

None.

An analysis of the compliance testing implications:
Cable compliance instruments (specifically, vector network analyzers) are required to span down to Fmin of 300KHz. The revised Fmin/Fmax need to be incorporated to CTS. The measured s-parameter file is post processed with a script that extracts the mutual term. The process will be documented in a white paper for reference.

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Actual Change

(a). Section 3.7.3.3.1, Page 81

From Text:

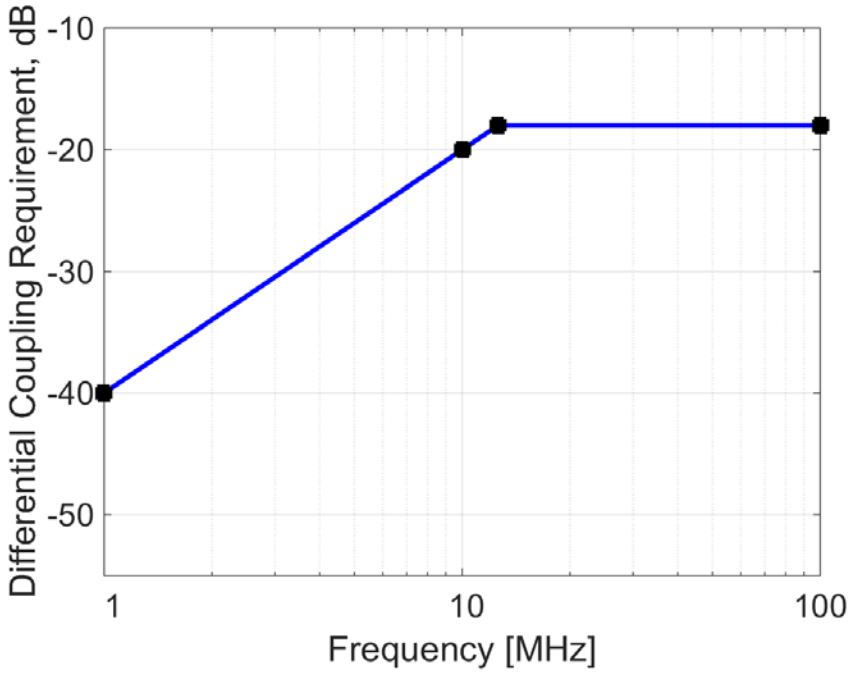
The differential coupling between the CC and D+/D− shall be below the limit shown in Figure 3-48. The limit is −40 dB at 1 MHz with a slope of 20 dB per decade until the slope intercepts a horizontal line at −18 dB, then continuing at −18 dB to 100 MHz.

To Text:

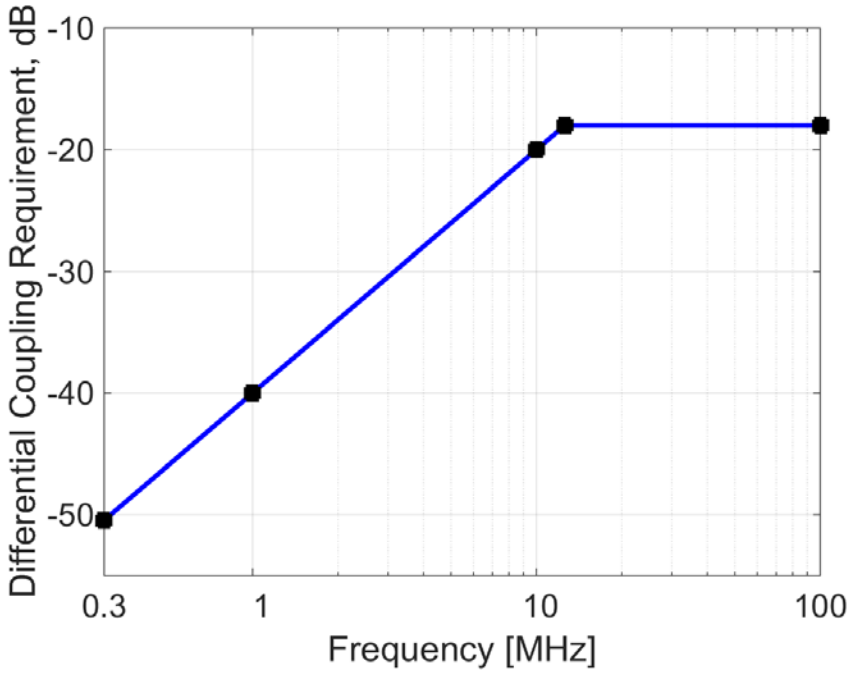
The differential coupling between the CC and D+/D− shall be below the limit shown in Figure 3-48. The limit is defined with the vertices of (0.3 MHz, -50.5 dB), (1 MHz, -40 dB), (10 MHz, -20 dB), (12.6 MHz, -18 dB), (100 MHz, -18 dB)~~=40 dB at 1 MHz with a slope of 20 dB per decade until the slope intercepts a horizontal line at =18 dB, then continuing at =18 dB to 100 MHz~~.

(b). Section 3.7.3.3.1, Page 82

From Figure 3-48:



To Figure 3-48:



(c). Section 3.7.3.3.2, Page 82

From Text:

The single-ended coupling between V_{BUS} and SBU_A/SBU_B2 and between VBUS and CC shall be less than the limits shown in Figure 3-49. The limit is defined by the vertices of (1 MHz, –40 dB), (10 MHz, –20 dB), and (100 MHz, –20 dB).

To Text:

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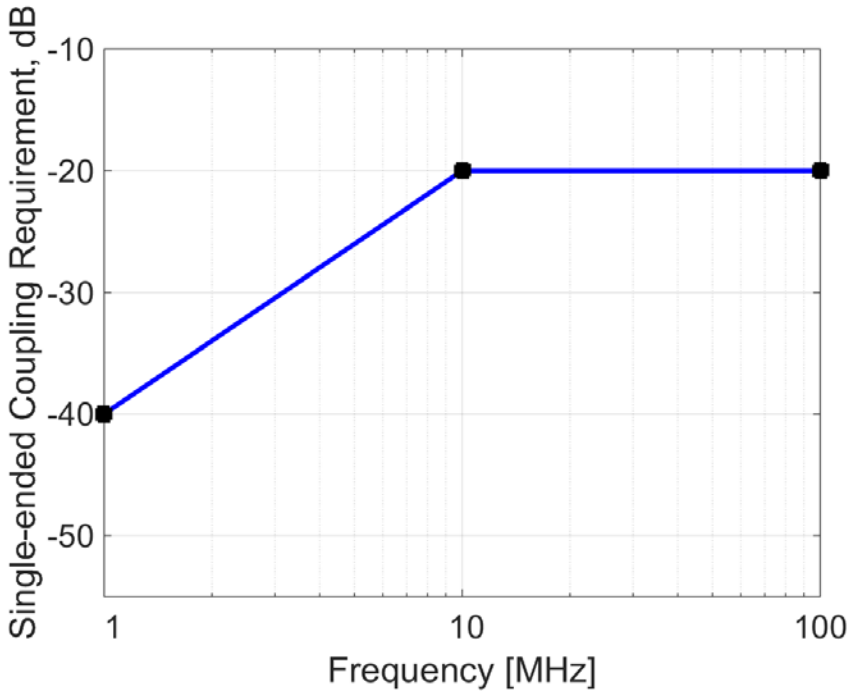
(d). Section 3.7.3.3.2, Page 82

From Figure 3-49:



To Figure 3-49:

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(e). Section 3.7.3.3.2, Page 82

From Text:

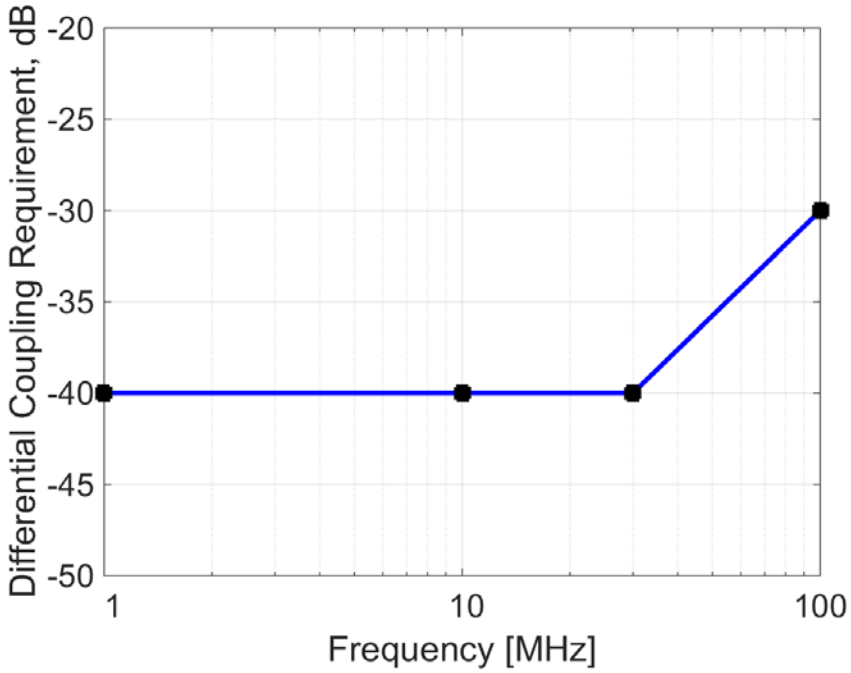
The differential coupling between VBUS and USB D+/D− is specified in Figure 3-50. The limit is defined by the following vertices: (1 MHz, -40 dB), (30 MHz, -40 dB), and (100 MHz, -30 dB).

To Text:

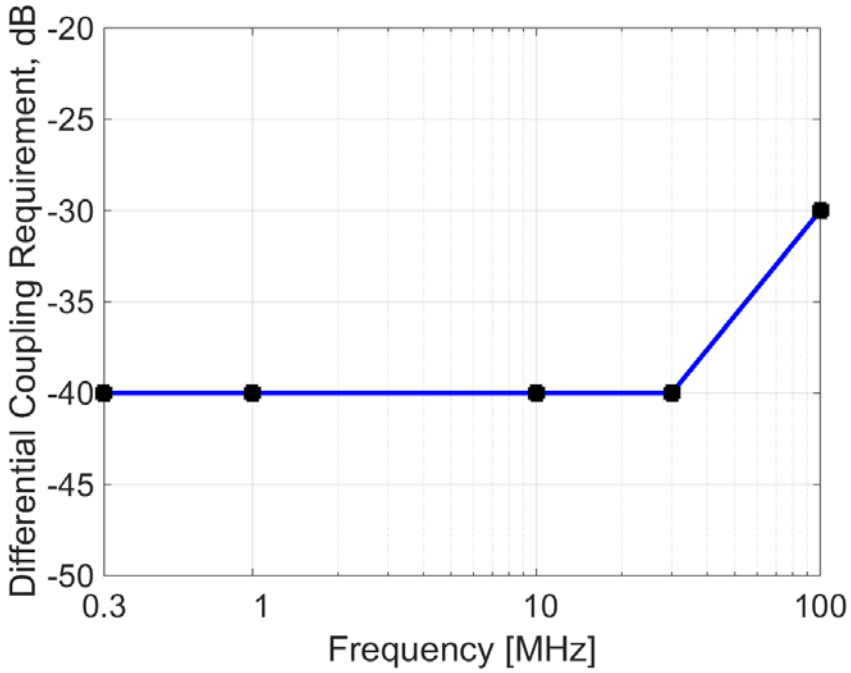
The differential coupling between VBUS and USB D+/D− shall be less than the limit shown ~~is specified~~ in Figure 3-50. The limit is defined by the following vertices: (0.3 MHz, -40 dB), (1 MHz, -40 dB), (30 MHz, -40 dB), and (100 MHz, -30 dB).

(f). Section 3.7.3.3.2, Page 83

From Figure 3-50:



To Figure 3-50:



(g). Section 3.7.3.3.2, Page 83

From Text:

The loop inductance of the VBUS line shall be controlled to limit the noises caused by load release on the VBUS line. The maximum loop inductance allowed is 900 nH.

To Text:

~~The loop inductance of the VBUS line shall be controlled to limit the noises caused by load release on the VBUS line. The maximum loop inductance allowed is 900 nH.~~

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 loop inductance of VBUS shall be 900 nH and the maximum mutual inductance coupling factor (k) between VBUS and low speed signal lines (CC, SBU_A, SBU_B, D+, D-) shall be 0.3. For fully featured cables, the range of VBUS bypass capacitance shall be 9nF up to 500nF as any of the values in the range is equally effective for high-speed return-path bypassing.

(h). Section 3.7.3.3.3, Page 83

From Text:

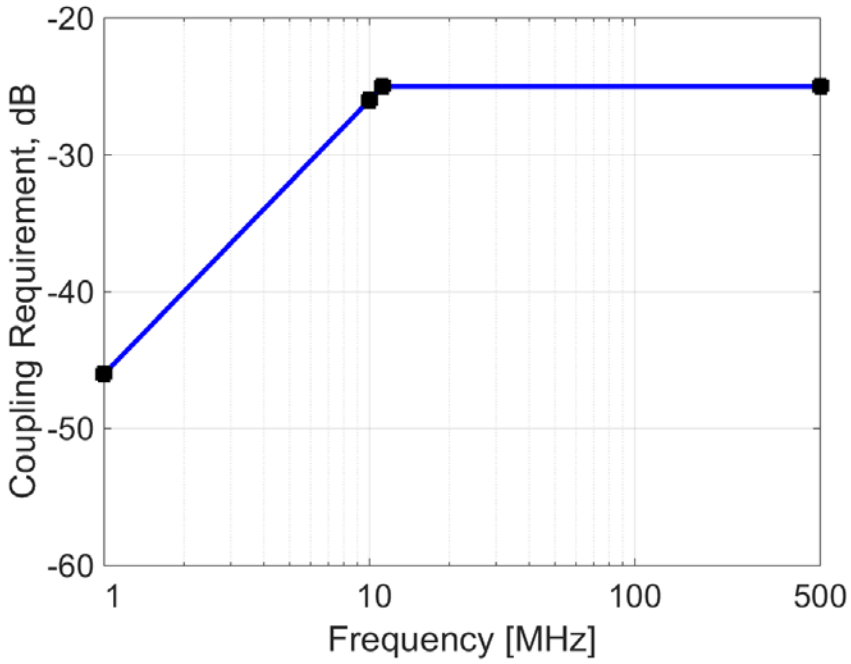
The single-ended coupling between SBU_A/SBU_B and CC and between SBU_A and SBU_B shall be less than the limits shown in Figure 3-51. The limit is defined with the vertices of (1 MHz, -46 dB), (10 MHz, -26 dB), (11.2 MHz, -25 dB), and (500 MHz, –25 dB).

To Text:

The single-ended coupling between SBU_A/SBU_B and CC and between SBU_A and SBU_B shall be less than the limit shown in Figure 3-51. The limit is defined with the vertices of (0.3 MHz, -56.5 dB), (1 MHz, -46 dB), (10 MHz, -26 dB), (11.2 MHz, -25 dB), and (100 MHz, –25 dB).

(i). Section 3.7.3.3.3, Page 83

From Figure 3-51:



To Figure 3-51: