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AN-6102

USB Type C, CC Pin Protection

Utilizing Zener Diode to protect CC Pin for A to C High Voltage Charging Application

When a USB Type A to USB Type C cable is used, the cable includes a Rp pull up from V_{BUS} to the CC pin, this is done so the type C device can detect the correct orientation of the plug, Figure 1 is an example of the Type A to Type C Cable.

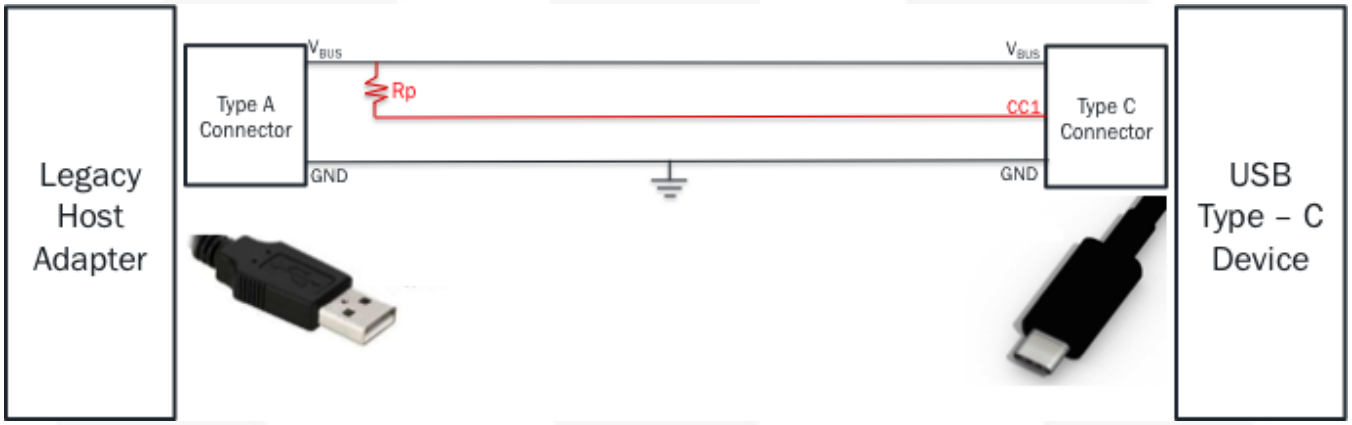

Figure 1. Example of Type A to Type C Cable

With this cable, it allows a Type C device to be backward compatible with existing devices. However, there are power adapters with fast charging protocols that utilizes the Type A connector for fast charging. When the end user enables the existing fast/high voltage charging, V_{BUS} can increase up to 20 V, this would cause the CC pin to also increase voltage beyond the absolute maximum specification of the device. To calculate the maximum voltage that could be present on the CC pin, use equation (1).

$$V_{CC} = V_{BUS} * \left(\frac{Rd}{Rp + Rd}\right) \quad (1)$$

With Rd enabled on the device, we can use 5.1 k for Rd and need to determine the Rp to calculate the voltage present on CC. Assuming worst case, we will use 4.7 kΩ Rp at 20 V $V_{BUS.}$ We can see that the V_{CC} can be as high as 10.4 V, the absolute maximum of the CC pin is 6 V so we can utilize the Zener diode to clamp down the voltage to protect the CC pin. However, since the CC pin is used for Type C and PD communication picking the right clamping voltage is imperative to preventing communication errors. A clamping voltage above 5 V but below 6 V is preferred. Table 1 shows two Zener diode part numbers that meet these requirements (5.1 V & 5.6 V).

Table 1. Zener Diode Example

Manufacturer	Manufacturers Part Number	Voltage – Zener (Nom) (V_Z)	Tolerance	Power- Max. (P_d)	Current-Reverse Leakage (I_r)
Bourns	CD1005-Z5V1	5.1 V	5%	200 mW	100 nA
Comchip	CZRF52C5V6	5.6 V	5%	200 mW	100 nA

One of the considerations when picking which Zener diode to use, is to review the Zener diode power dissipation specification. When the Zener diode is activated the maximum current can be calculate by the VBUS voltage and the Rp value, If we use 20 V and 4.7 kΩ Rp we will get 4.26 mA though the Rp resistor, and the Zener diode would need to dissipate 85 mW of power to protect the device. So selecting the correct Zener diode would be the key for this protection to work as the 2 recommended Zener diode is rated to have 200 mW maximum power and its capacitance should be no larger than 600 pF as per PD specification cReceiver requirements of 200 pF min to 600 pF maximum.

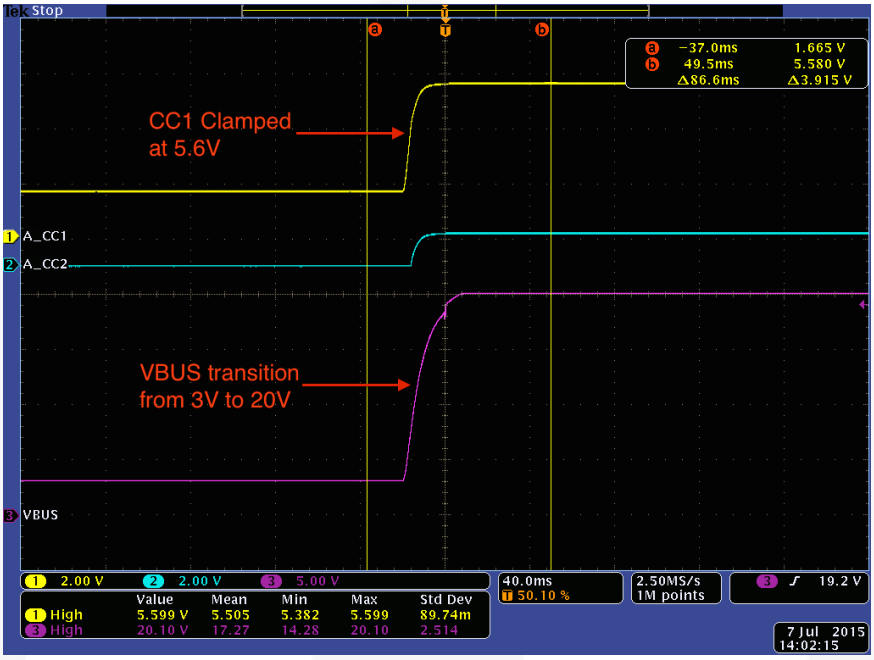

Figure 2. 5.6 V Zener Diode on CC

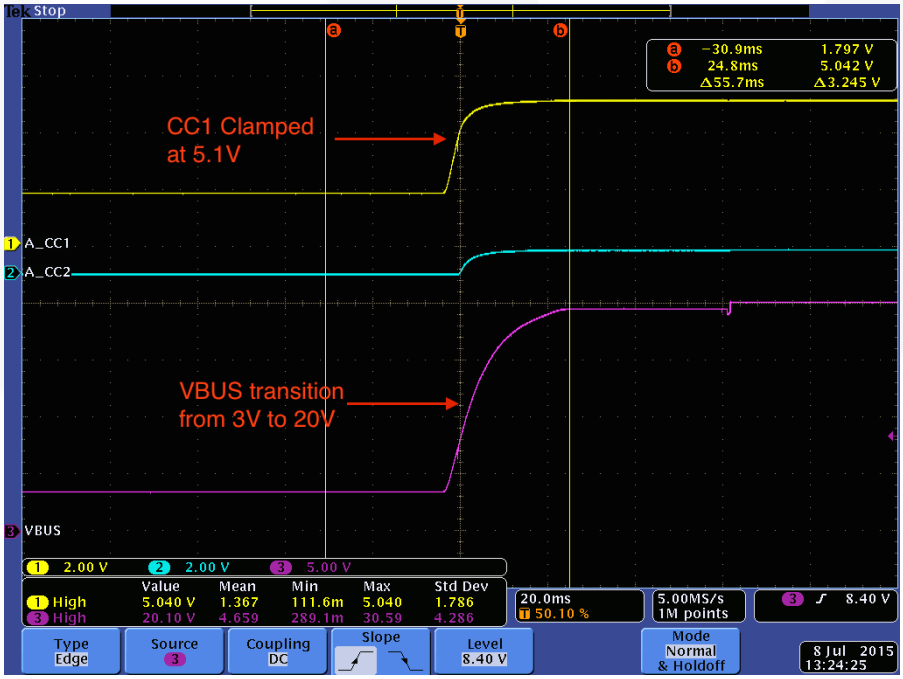

Figure 3. 5.1 V Zener Diode on CC

Reference Schematic with FUSB302

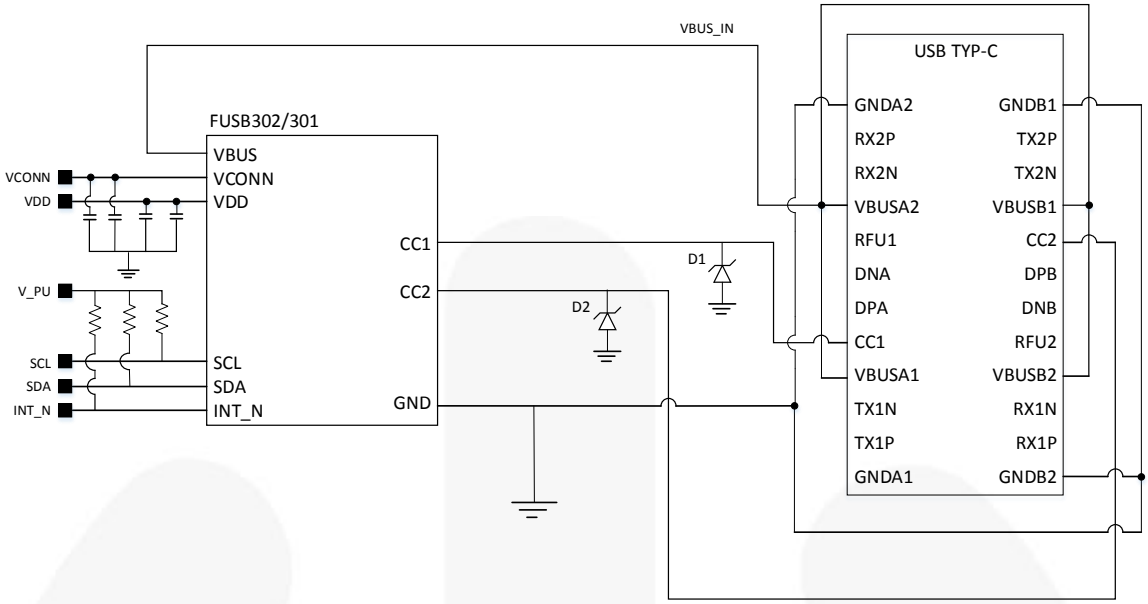

Figure 4. Reference Schematic

Note:

1. The recommended placement of the Zener diode, is as close to the device as possible.

Related Datasheets

FUSB300C—Programmable USB Type-C Controller

FUSB301—Datasheet Brief

FUSB301A—Autonomous USB Type-C Control with Configurable I^2C Address

FUSB302—Programmable USB Type-C Controller w/PD

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