

USB 3.1/USB Type-C



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September 23, 2015

Universal Serial Bus (USB) is a standard developed in mid-1990s to standardize the connection between computers and peripherals, both to communicate and to supply electrical power. It replaced a variety of earlier interfaces such as serial/parallel ports, PS/2, and separate power chargers for portable devices.

There are 3 connector sizes- standard, mini, and micro, type “A”, “B”, and “AB” connectors and corresponding receptacles, and 5 data transfer mode summarized in Table 1:

Table 1. USB Data Transfer Modes

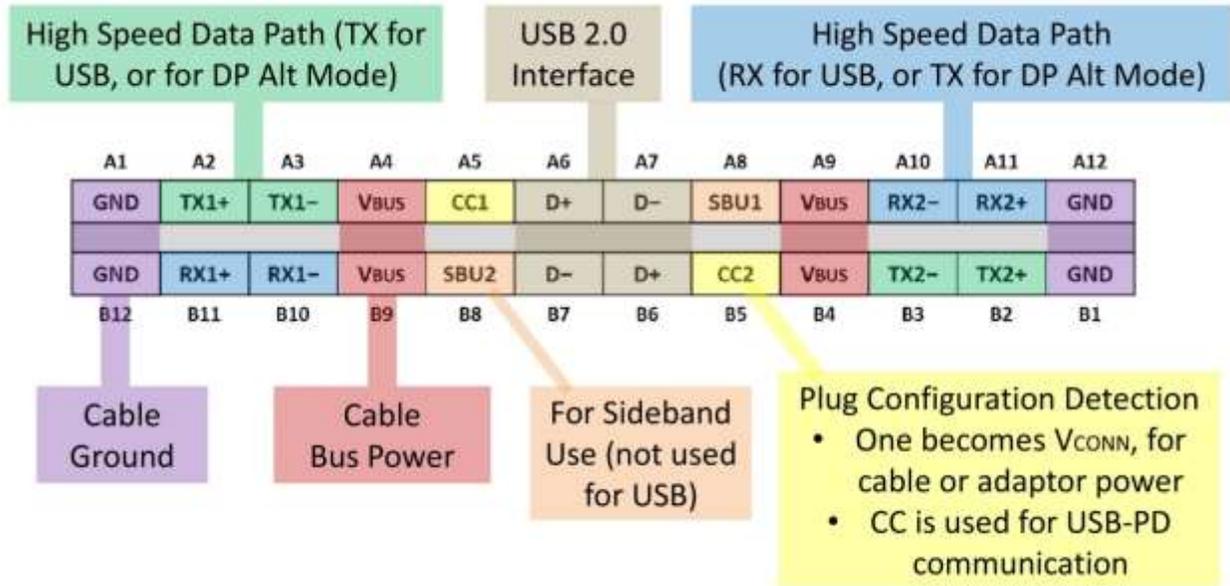
USB Type	Throughput	Direction	Total Capacitance	Pin Count
1.X	1.5 Mbit/s (Low speed) 12 Mbit/s (Full speed)	Half Duplex; Not reversible	< 30pF	4
2.0	480 Mbit/s (High Speed)	Half Duplex; Not reversible	< 10pF	4-5
3.0	5 Gbit/s (SuperSpeed)	Full Duplex; Not reversible	< 1pF	9
3.1/Gen2	10 Gbit/s (SuperSpeed+)	Full Duplex; Not reversible	< 0.1~0.5pF	9
Type-C	10 Gbit/s (SuperSpeed+)	Full Duplex; Reversible	< 0.1pF	24

USB 3.1/Gen 2 is essentially USB 3.0 with double the speed, to 10 Gbit/s. It is full duplex and not reversible, so the connector and receptacle has to be aligned in the correct orientation to be inserted. It has a total capacitance of 0.1~0.5pF

USB Type-C is 10 Gbit/s and reversible (similar to Apple’s Lightning), with symmetrical 24 pins so the connector will attach to the receptacle on the first try. The additional pins permit support of data protocols such as DisplayPort 1.3, PCI Express, and Base-t Ethernet using Type C cables. Figure 1 shows the pinout diagram of USB Type-C cable.

USB Type-C’s connector and receptacle are smaller sized (similar to Lightning and Micro-USB) and more durable, withstanding 10,000 insertion/removal cycles. The cable supports USB power Delivery mode of up to 100W, which charges smart phones and tablets much faster. Devices that currently accommodate USB Type-C cable are Apple’s 2015 MacBook, Google’s Chromebook Pixel, Nokia’s N1 tablet, smart phones such as OnePlus 2 and Le Superphone, and mobile storage devices by LaCie and SanDisk.

Figure 1. USB Type-C Pinout Diagram



Comchip has many low capacitance ESD surge suppressors for USB port protection. Recommended parts for USB 3.0 are listed in Table 2 and suggested PCB layouts are shown in Figures 2 and 3. Suggested parts and layouts for USB 3.1 are shown in Figures 4 and 5. Recommended parts for Type-C are listed in Table 3 and suggested flow-through PCB layout is in Figure 6.

Table 2. Recommended parts for USB 3.0

USB 2.0 D+, D- (USB 2.0 and 3.0 data lines are combined into one)

Part Number	VRWM	IR(Max)	VC	Cj	ESD(Contact)	Package
CPDQR5V0USP-HF	5V	1uA	13V	0.6pF	±8KV	0402 1-Line/Uni
CPDQ5V0USP-HF	5V	1uA	13V	0.6pF	±8KV	0402 1-Line/Uni
CPDQC5V0USP-HF	5V	1uA	13V	0.6pF	±8KV	0402C 1-Line/Uni

Table 2 (continued). Recommended parts for USB 3.0

USB 2.0 D+, D- (USB 2.0 and 3.0 data lines are combined into one) continued

Part Number	VRWM	IR(Max)	VC	Cj	ESD(Contact)	Package	
CPDU5V0USP-HF	5V	1uA	9.8V	0.5pF	±10KV	0603 1-Line/Uni	
CPDUC5V0USP-HF	5V	1uA	9.8V	0.5pF	±10KV	0603C 1-Line/Uni	
CPDT-5V0USP-HF	5V	1uA	12V	0.6pF	±16KV	SOT-23 2-Line/Uni	

USB 3.0 Tx, Rx

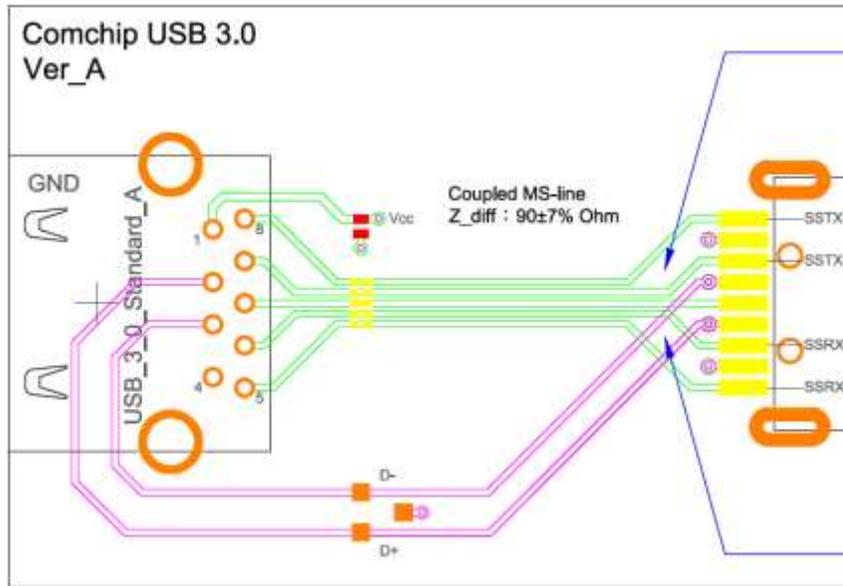
Part Number	VRWM	IR(Max)	VC	Cj	ESD(Contact)	Package	
CPDQC5V0CSP-HF	5V	100A	15V	0.3pF	±8KV	0402C 1-Line/Bi	
CPDQC5V0USP-IPHF	5V	100nA	12V	0.3pF	±10KV	0402C 1-Line/Uni	
CPDA10R5V0P-HF	5V	50nA	9V	0.25pF	±18KV	DFN10P 4-Line/Uni	

VBUS 5V

Part Number	VRWM	IR(Max)	VC	Cj	ESD(Contact)	Package	
CPDQC5V0R-HF	5V	90nA	8V	24pF	±30KV	0402C;1-Line/Bi	
CPDUR5V0R-HF	5V	90nA	8V	24pF	±30KV	0603;1-Line/Bi	
CPDUC5V0R-HF	5V	90nA	8V	24pF	±30KV	0603C;1-Line/Bi	
CPDQR5V0HE-HF	5V	1uA	11V	15pF	±30KV	0402;1-Line/Bi	
CPDQC5V0HE-HF	5V	1uA	11V	15pF	±30KV	0402C;1-Line/Bi	

Part Number	VRWM	IR(Max)	VC	Cj	ESD(Contact)	Package
CPDUR5V0HE-HF	5V	1uA	11V	15pF	±30KV	0603;1-Line/Bi 

Figure 2. USB 3.0 Suggested PCB Layout Diagram using 3 components



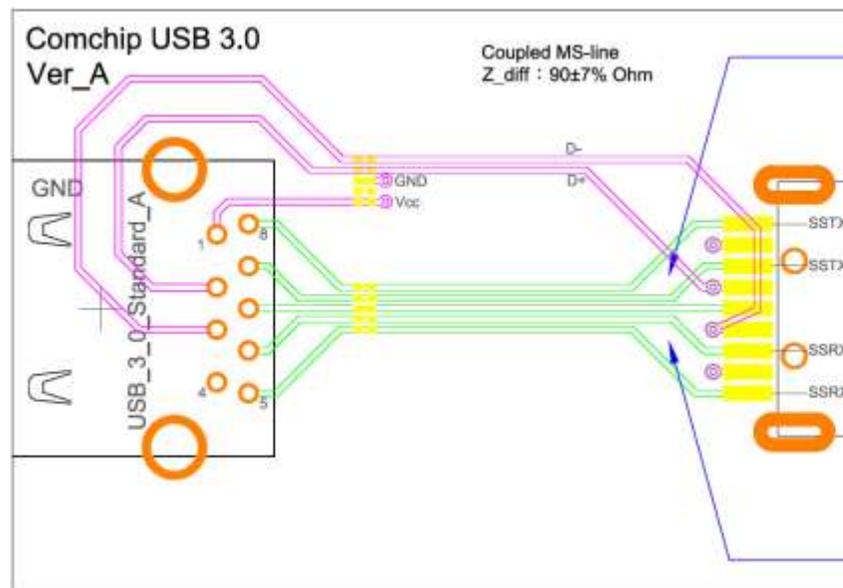
  CPDQR5V0HE-HF

  CPDA10R5V0P-HF

  CPDT-5V0USP-HF

Identical line-length is imperative for Tx-/Tx+ and for Rx+/Rx- to minimize skew

Figure 3. USB 3.0 Suggested PCB Layout Diagram using 2 components



  CPDA10R5V0P-HF
For the USB2.0 Link
Including Vcc

  CPDA10R5V0P-HF
CPDA10R5V0P-HF
For the USB3.0 Link

Identical line-length is imperative for Tx-/Tx+ and for Rx+/Rx- to minimize skew

USB 3.1 Type A has similar ESD requirements to USB 3.0 Type A, so the suggested PCB layouts are the same, except lower capacitance ESD components are recommended. Suggested PCB layouts for USB 3.1 are shown in Figure 4 and 5.

Figure 4. USB 3.1 Suggested PCB Layout Diagram using 3 components

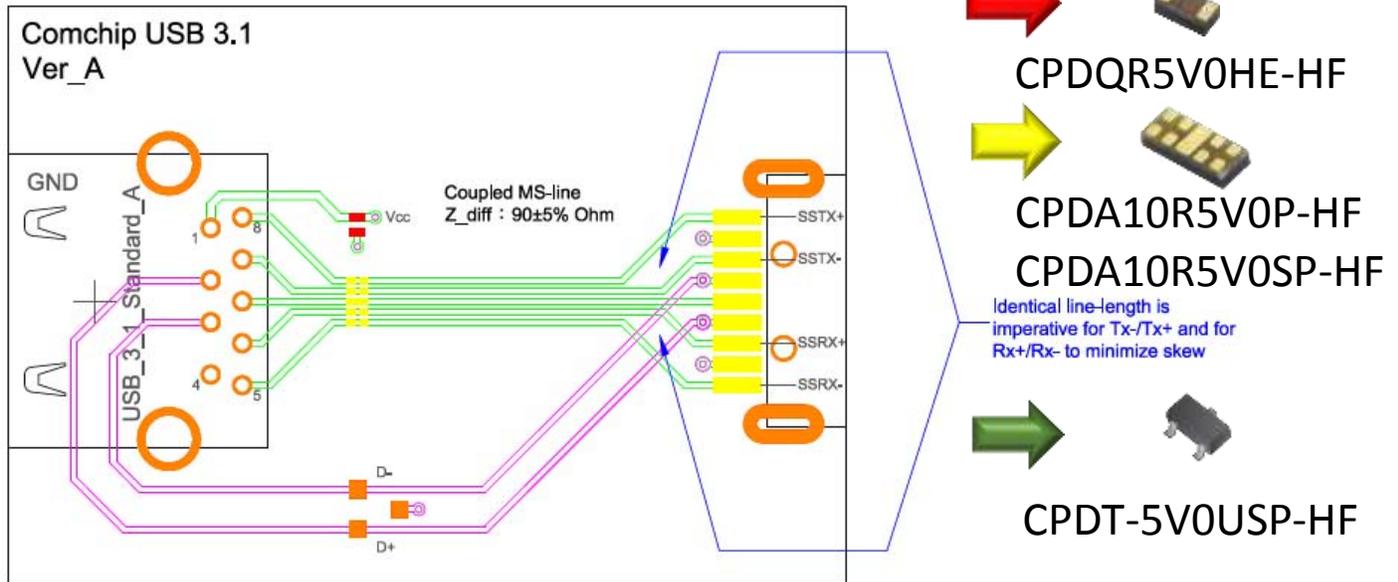
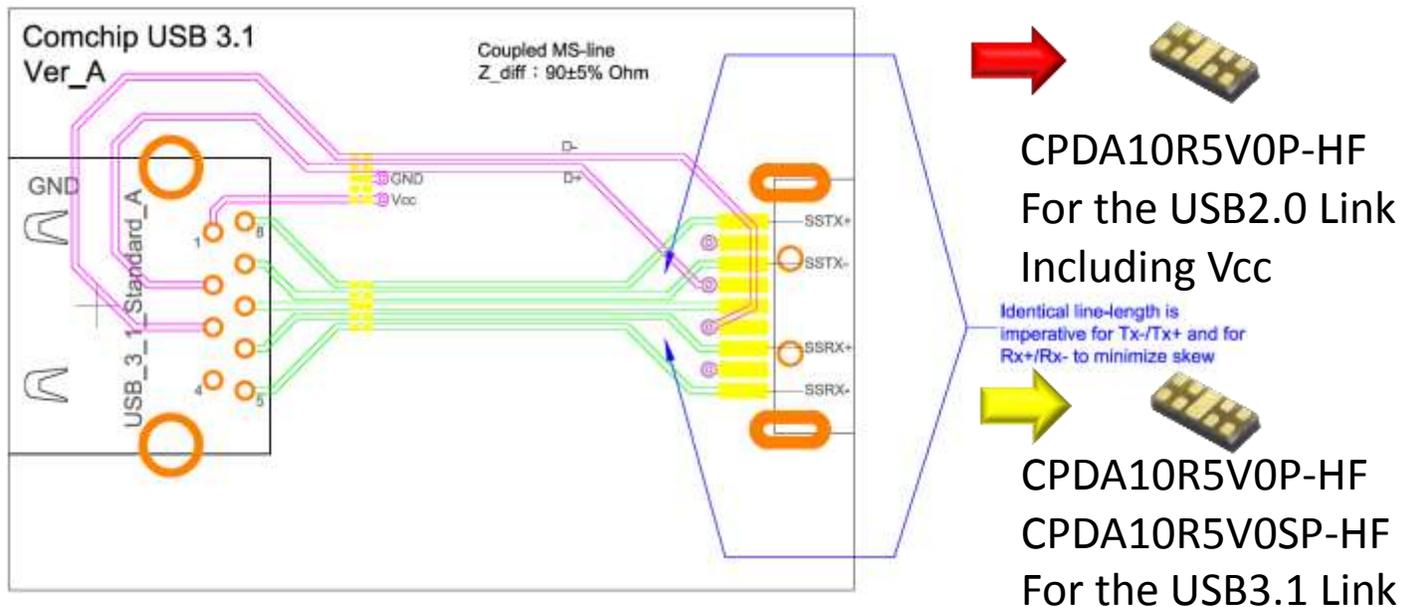


Figure 5. USB 3.1 Suggested PCB Layout Diagram using 2 components



USB Type-C has 10 Gbit/s throughput so ESD protection is essential considering the potential impact of additional capacitance and inductance on the high-speed differential pairs. Due to the reversible connector design, USB Type-C has increased ESD protection requirement.

In such instance, a flow-through design of Comchip's DFN10P package simplifies PCB layout by placing the package on top of the high speed differential pair, avoiding complicated vias or loops and saving PCB space. Recommended parts for USB Type-C are listed in Table 3 and suggested PCB layout is shown in Figure 6.

Table 3. Recommended parts for USB Type-C

Part Number	V_{RWM}	IR(Max)	V_C	C_j	ESD(Contact)	Package
CPDA10R5V0P-HF	5V	50nA	11	0.25	±14KV	DFN10P 4-Line/Bi
CPDA10R5V0SP-HF	5V	50nA	12	0.15	±14KV	DFN10P 4-Line/Bi

Figure 6. USB Type-C Suggested PCB Layout Diagram with Flow-Through Design

