SEMTECH

Protection Solutions – USB Type-C, USB PD 20V

SEMTECH - PROTECTION SOLUTIONS

Semtech USB Type-C has made charging electronics more convenient than ever. Yet, this has also led to these ports being more vulnerable to electrical overstress than ever before. Discover how TVS diodes deliver essential protection to keep devices reliable and damage-free.

ESD Protection of USB Type-C

USB technology is integral to our digital lives. The newest USB Type-C standard not only allows reversible plug orientation but also enables faster charging than previous USB versions. These features have made it a standard in most connected devices. However, USB Type-C ports face a risk of electrostatic discharge (ESD) during plug-in and unplugging, which can damage devices. Effective ESD protection for these compact ports is essential to ensure device reliability.

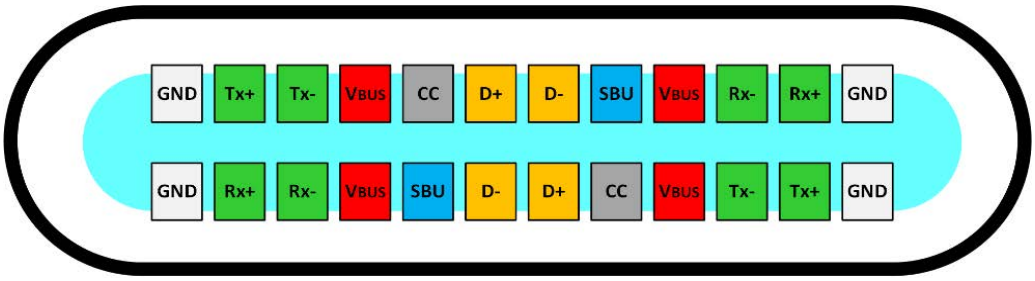
One effective protection method is using a Transient Voltage Suppressor (TVS) diode. With their small form factor, these diodes are easier for device manufacturers to incorporate. Different components of USB Type-C interfaces require specific circuit protection based on operating voltage, response time, and clamping voltage. Because these ports are often exposed to potentially damaging ESD spikes, safeguarding them is critical for device functionality.

FEATURES

- Small footprint
- Low clamping voltage
- Low capacitance
- High ESD rating

APPLICATIONS

- Consumer electronics
- Handheld devices
- Wearables
- Manufacturing
- Industrial automation
- Test and measurement



USB 3.x High Speed Data Lines | Secondary Bus | VBus | USB 2.0 Interface | Power Delivery Communication | Ground

ESD Protection of USB Type-C

Protecting USB interfaces from electrostatic discharge (ESD) is crucial. Frequent plugging and unplugging of USB cables can generate ESD, either from the user or a charged cable, reaching voltages high enough to damage the USB transceiver's CMOS structures. ESD protection for each USB pin is therefore essential. Due to the small size and close pin arrangement of USB Type-C ports, protecting against ESD is particularly challenging. The closely spaced pins increase the risk of short circuits, especially if conductive particles create unintended connections. Additional transient protection is necessary to prevent these short circuits.

SBU AND CC PINS PROTECTION

Due to the small size and close spacing of USB Type-C pins, discrete TVS diodes are ideal for protecting against ESD events. Since the CC and SBU pins are near the 20V VBUS pin, a TVS diode with at least a 20V breakdown, like Semtech's µClamp2411ZA, is needed. This diode withstands up to ±20kV (Air) and ±17kV (Contact) ESD and operates at 24V in a compact 0201 package.

VBUS PIN PROTECTION

The VBUS pin requires a TVS diode with over 20V operating voltage, fast response, and low clamping voltage, such as Semtech's TDS2211P. This device has a 22V working voltage and can handle peak pulse currents of 40A. Low capacitance is not required for VBUS.

HIGH-SPEED DIFFERENTIAL LINES PROTECTION

The Tx+/Tx- and Rx+/Rx- lines handle high-speed data at 10Gbps, so low junction capacitance is essential. Semtech's RClamp3391ZC, with ±15kV (Air) and ±8kV (Contact) ESD withstand and 3.3V working voltage, offers a capacitance of just 0.20pF in a 0201 package.

D+/D- LINES PROTECTION

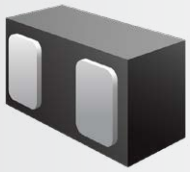
For USB 2.0 lines, Semtech's RClamp4041ZA provides effective protection. This 4V TVS diode features a 0.65pF maximum capacitance and low 0.07Ω dynamic resistance, housed in a small 0201 package.

USB Type-C USB PD 20V Protection Solutions								
Part Number	Working Voltage (V)	Capacitance (pF) (Max)	Lines	16A TLP Clamp (V)	Dynamic Resistance (Ohms)	Surge (A)	IEC 61000-4-2 ESD Rating (kV) (Contact/Air)	Package Size (mm)
RClamp4041ZA	±4	0.65	1	3.7	0.07	20	±30/±30	0.6x0.3x0.25
RClamp04041PW	±4	0.65	1	4.0	0.1	20	±30/±30	1.0x0.6x0.55
RClamp2261ZA	±22	0.5	1	8.6	0.22	18	±25/±30	0.6x0.3x0.25
RClamp2261PW	±22	0.5	1	7.7	0.16	18	±25/±30	1.0x0.6x0.55
RClamp1011ZC	±1.0	0.2	1	11.6	0.32	2.5	±10/±15	0.6x0.3x0.25
RClamp3391ZC	±3.3	0.2	1	5.5	0.18	7	±8/±15	0.6x0.3x0.25
RClamp03391PW	±3.3	0.25	1	5.3	0.18	7	±8/±15	1.0x0.6x0.55
uClamp2411ZA	±24	15	1	48	1	3	±17/±20	0.6x0.3x0.25
uClamp2411PW	±24	15	1	41.5	0.4	3	±17/±20	1.0x0.6x0.55

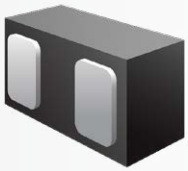
Part Number	Working Voltage (V)	Capacitance (pF) (TYP)	Lines	16A TLP Clamp (V)	Vclamp @ Ipp	Surge (A)	IEC 61000-4-2 ESD Rating (kV) (Contact/Air)	Package Size (mm)
TDS2201P	22	58	1	28	28	16	±8/±30	1.0x0.6x0.25
TDS2221PW	22	98	1	NA	28	22	±15/±30	1.6x1.0x0.55
TDS2211P	22	175	1	NA	28	40	±30/±30	1.6x1.6x0.55
TDS2261P	22	170	1	NA	28	40	±20/±30	2.0x2.0x0.75
uClamp2271P	22	165	1	34	55	25	±30/±30	1.6x1.0x0.50

USB 3.x High Speed Data Lines | Secondary Bus | VBus | USB 2.0 Interface | Power Delivery Communication

FEATURED PRODUCTS

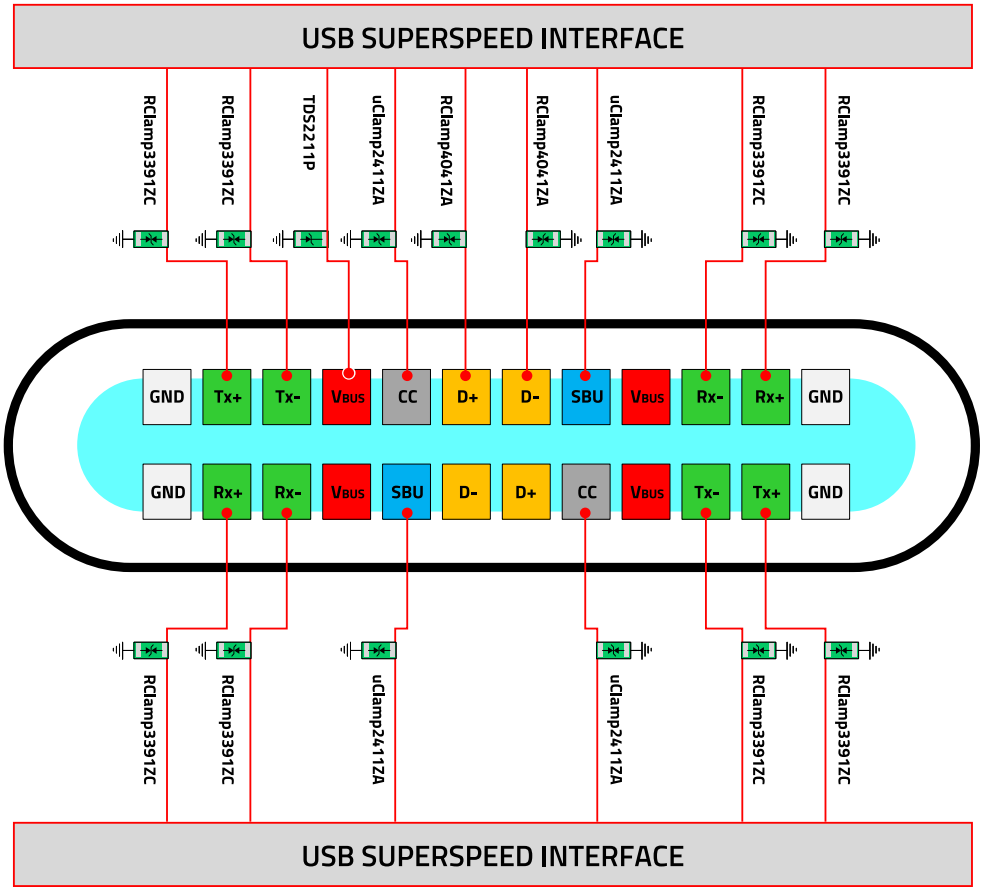


RClamp1011ZC
Femto Farad RailClamp®
1-Line, 200fF
ESD Protection



RClamp3391ZC
Femto Farad RailClamp®
1-Line, 200fF
ESD and EOS Protection

TDS2211P
SurgeSwitch™
1-line 22V
EOS Protection



Contact us to Learn More

Learn more about Semtech's **Circuit Protection products** at www.semtech.com
or email sales@semtech.com for more information.

About Semtech
Semtech Corporation (Nasdaq: SMTC) is a high-performance semiconductor, IoT systems and cloud connectivity service provider dedicated to delivering high-quality technology solutions that enable a smarter, more connected and sustainable planet. Our global teams are committed to empowering solution architects and application developers to develop breakthrough products for the infrastructure, industrial and consumer markets.

To learn more about Semtech technology, visit us at **Semtech.com** or follow us on **LinkedIn** or **X.**

"Semtech", "Sierra Wireless" are registered trademarks of Semtech Corporation or its subsidiaries. Other product or service names mentioned herein may be the trademarks of their respective owners. © 2025 Sierra Wireless, Inc. © 2025 Semtech Corporation. All rights reserved. 2025.08.26