PROTECTION PRODUCTS

Description

Transient Diverting Suppressors (TDS) are designed to provide protection from Electrical Overstress (EOS) events. They have superior clamping and temperature characteristics when compared to standard TVS devices. The device uses a surge rated FET as the main protection element. A precisely tuned trigger circuit activates the shunt FET when an EOS event is detected. The TDS clamping voltage is nearly constant across the rated peak pulse current range due to the extremely low ON Resistance of the FET.

TDS2211P is designed to protect voltage bus or data lines with an operating voltage as high as 22V. It is rated for a high-energy transient current up to 40A (t_p = 8/20μs) and may be used to meet the common industrial voltage surge standard of ±1kV (R_S = 42Ω, C_S= 0.5μF).

TDS2211P is in a small DFN 1.6mm x 1.6mm x 0.55mm 6- Lead package and represents significant board space savings over traditional solutions.

Features

- High ESD Withstand Voltage: ±30kV (Contact) and ±30kV (Air) per IEC 61000-4-2
- High peak pulse current capability:
  40A (t_p = 8/20μs) per IEC 61000-4-5
  ±1kV (t_p = 1.2/50μs, R_S = 42Ω) per IEC 61000-4-5 for unsymmetrical lines
- High EFT Withstand Voltage: ±4kV (100kHz and 5kHz, 5/50ns) IEC 61000-4-4
- Constant clamping voltage across the rated peak pulse current range and temperature range
- Protects one I/O or power line
- Working voltage: 22V
- Solid-state technology

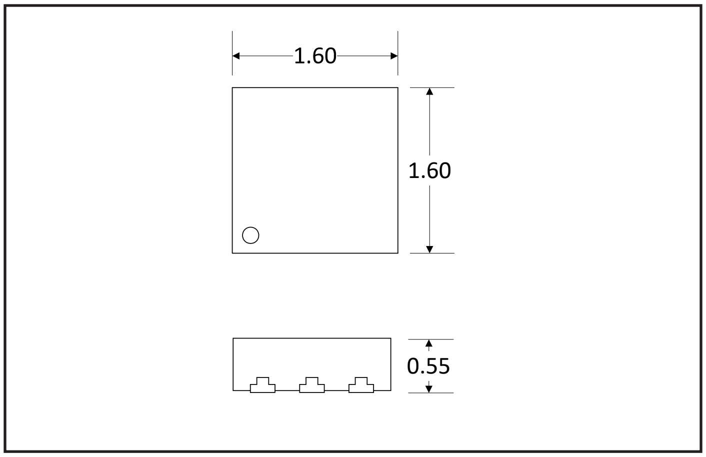
Mechanical Characteristics

- Package: DFN 1.6mm x 1.6mm x 0.55mm 6-Lead
- Pb-Free, Halogen Free, RoHS/WEEE Compliant
- Molding compound flammability rating: UL 94V-0
- Lead Finish: Lead-Free
- Marking: Marking code and Date Code
- Packaging: Tape and Reel

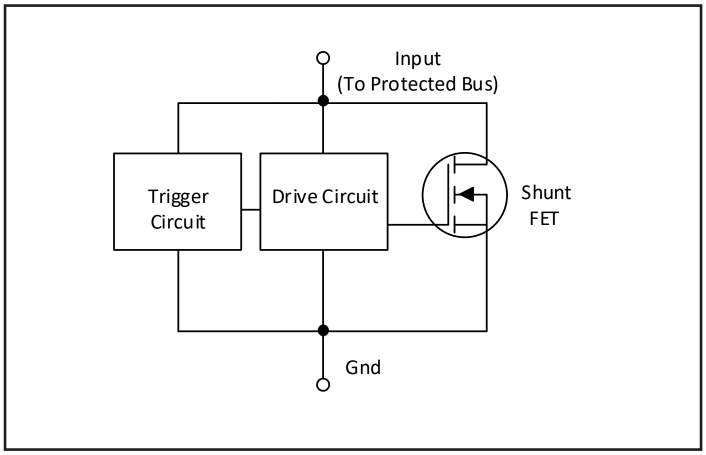
Applications

- USB PD
- USB Type-C
- IoT Devices
- Storage Devices
- Industrial Equipment
- Notebooks and Tablet Computers
- Load Switch Input Protection

Package Dimension (mm)



Functional Diagram



Absolute Maximum Rating (T=25°C unless otherwise specified)

Rating	Symbol	Value	Units
Peak Pulse Power (t_p = 8/20μs)	P_{PK}	1120	W
Peak Pulse Current (t_p = 8/20μs)	I_{PP}	40	A
ESD per IEC 61000-4-2 (Air)(1) ESD per IEC 61000-4-2 (Contact)(1)	V_{ESD}	±30 ±30	kV
Operating Temperature	T_{OP}	-40 to +125	°C
Junction & Storage Temperature	T_J , T_{STG}	-55 to +150	°C

Electrical Characteristics (T=25°C unless otherwise specified)

TDS2211P

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	V_{RWM}	Pin 4, Pin 5 and Pin 6 to Pin 1, Pin 2 and Pin 3			22	V
Reverse Breakdown Voltage	V_{BR}	I_t = 1mA, Pin 4, Pin 5 and Pin 6 to Pin 1, Pin 2 and Pin 3	25		27.9	V
Forward Voltage	V_F	I_t = 1mA, Pin 1, Pin 2 and Pin 3 to Pin 4, Pin 5 and Pin 6		0.5		V
Reverse Leakage Current	I_R	V_{RWM} = 22V, Pin 4, Pin 5 and Pin 6 to Pin 1, Pin 2 and Pin 3		130	600	nA
Clamping Voltage (2)	V_C	I_{PP}=24A, t_p = 1.2/50μs (Voltage), 8/20μs (Current) Combination Waveform, R_S =2Ω, Pin 4, Pin 5 and Pin 6 to Pin 1, Pin 2 and Pin 3		27.5	28	V
		I_{PP}=40A, t_p = 1.2/50μs (Voltage), 8/20μs (Current) Combination Waveform, R_S =2Ω, Pin 4, Pin 5 and Pin 6 to Pin 1, Pin 2 and Pin 3		27.6	28	V
Dynamic Resistance (2), (3)	R_{DYN}	t_p = 8/20μs		20		mΩ
Junction Capacitance	C_J	V_R = 22V, f = 1MHz		175		pF

Notes:

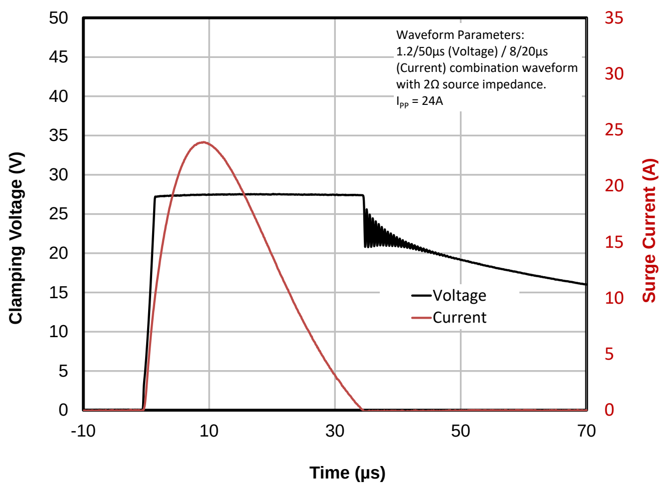
1) ESD gun return path connected to ESD ground plane.

2) Parameter guaranteed by design.

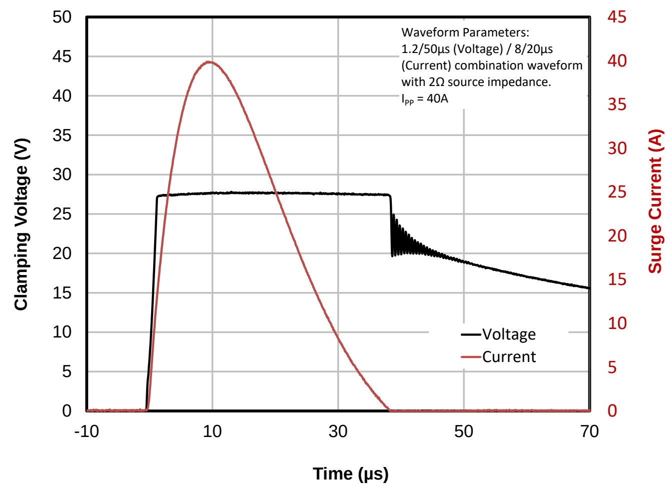
3) Dynamic resistance measured between 1A and 40A (t_p = 8/20μs).

Typical Characteristics

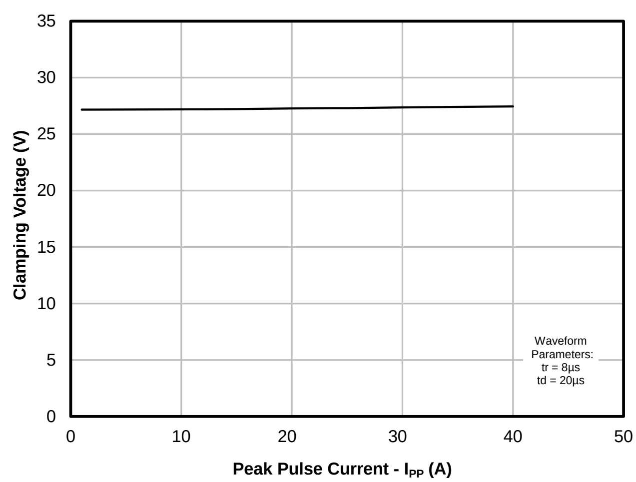
Clamping Voltage (t_p=1.2/50μs, I_{PP}= 24A)



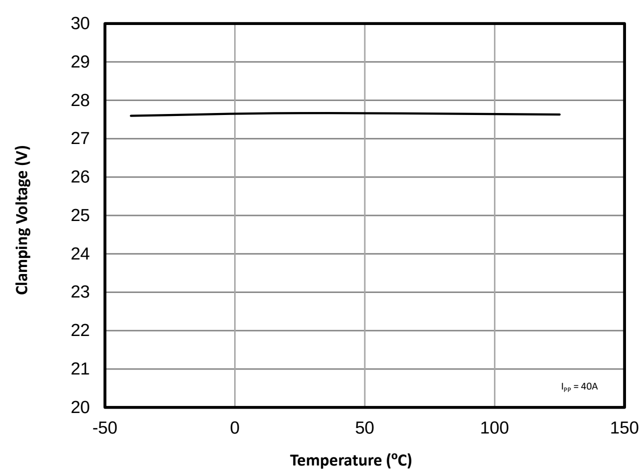
Clamping Voltage (t_p=1.2/50μs, I_{PP}= 40A)



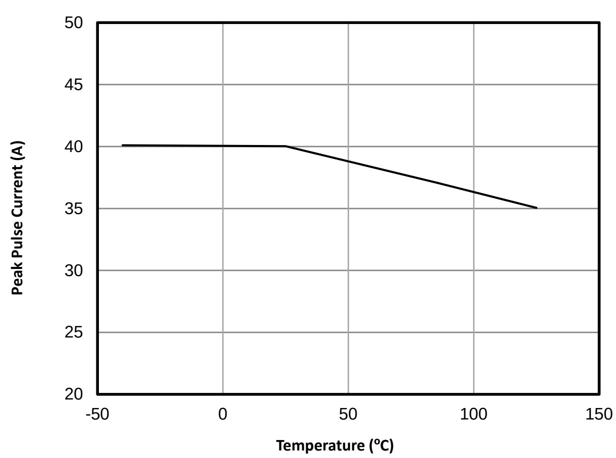
Clamping Voltage vs. Peak Pulse Current (t_p=8x20μs)



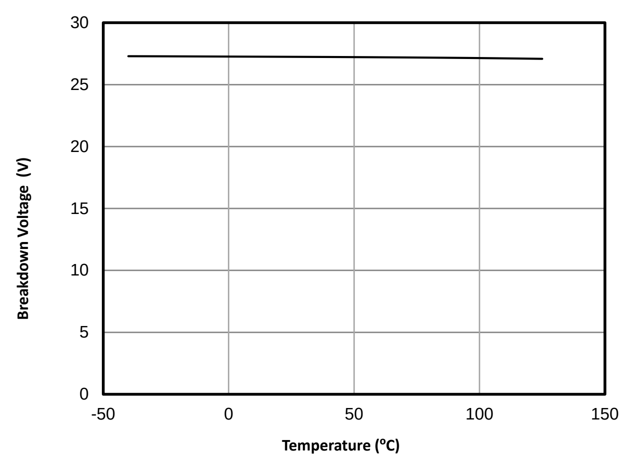
Clamping Voltage (t_p=1.2/50μs, I_{PP}= 40A) vs Temperature



Peak Pulse Current (t_p=8x20μs) vs Temperature

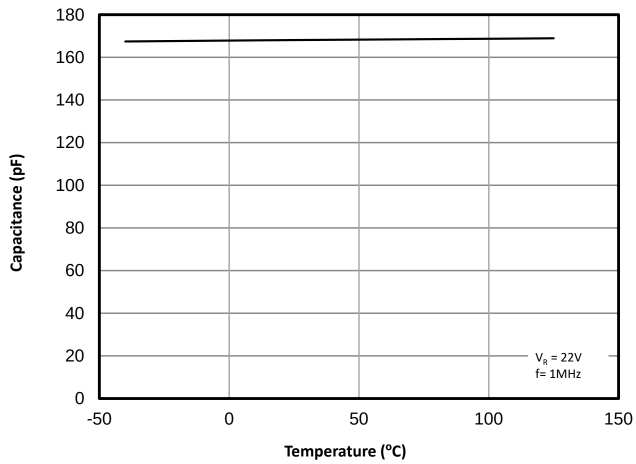


Breakdown Voltage vs. Temperature

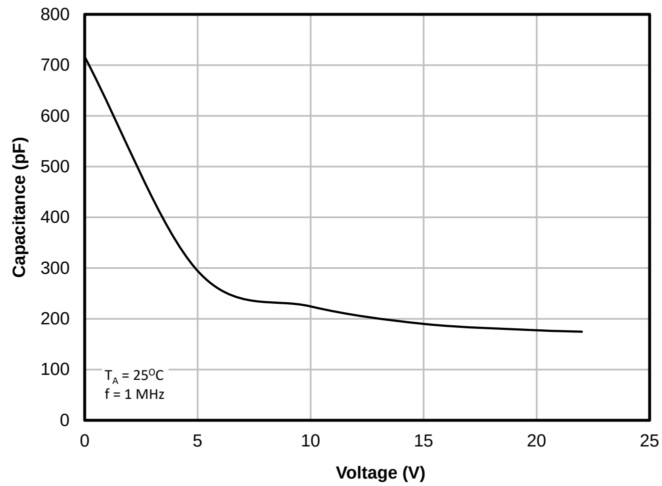


Typical Characteristics

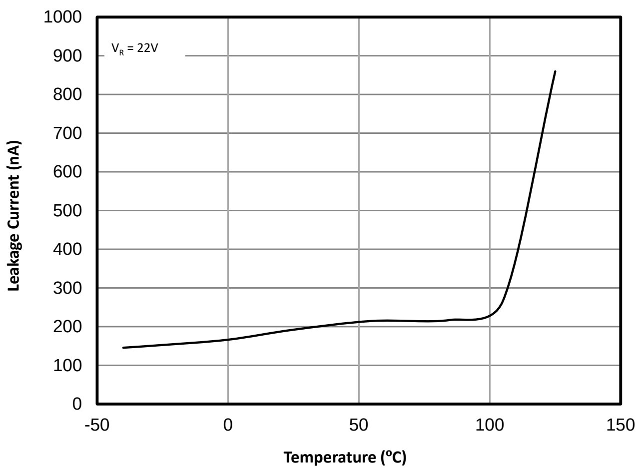
Capacitance vs. Temperature



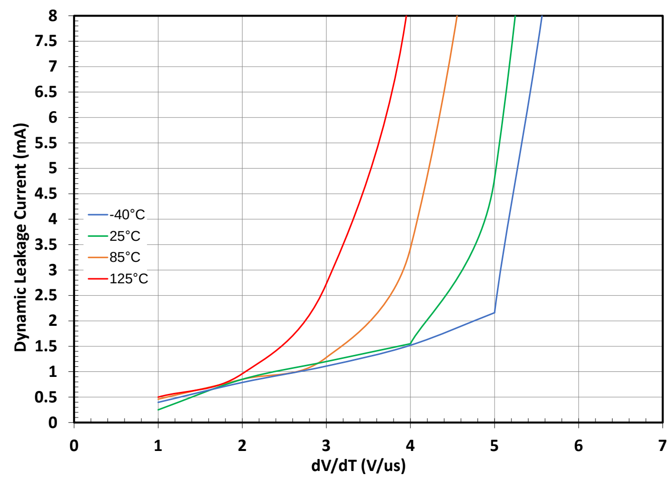
Capacitance vs. Reverse Voltage



Reverse Leakage vs. Temperature



Dynamic Leakage vs. Signal Slew Rate over Temperature



Application Information

Description

Transient Diverting Suppressors(TDS) are designed to provide high energy EOS protection with superior clamping and temperature characteristics when compared to standard TVS devices.

Conventional pn-junction TVS diodes have an inherent, fixed resistance value or dynamic resistance (R_{DYN}). TVS clamping voltage is given by the equation: $V_C = V_{BR} + I_{PP} * R_{DYN}$. Since the dynamic resistance is a fixed value, clamping voltage increases with increased I_{PP} resulting in a linear rise in clamping over the peak pulse current range. Additionally, conventional TVS dissipate surge energy in the junction of the device. Therefore, the capability to absorb transient current is related to the junction area and junction (ambient) temperature. As ambient temperature increases, the clamping voltage increases and the maximum I_{PP} capability decreases.

Transient Diverting Suppressors use a surge rated FET as the main protection element (Figure 1). The FET behaves like a voltage controlled switch which is activated by a precision trigger circuit (Figure 2). During an EOS event, transient voltage increases beyond the breakdown voltage of the trigger circuit. This in turn activates the drive circuit and turns on the shunt FET, effectively "closing the switch" and conducting transient current to ground. As the I_{PP} rises, the FET Rds(on) decreases to a negligibly small value, resulting in a clamping voltage with the same approximate value as the trigger circuit breakdown voltage. Therefore, the TDS clamping voltage is nearly constant across the rated peak pulse current range. The clamping also remains stable over the operating temperature range.

A comparison of clamping voltage vs. peak pulse current and Temperature for a conventional TVS and TDS2211P is shown in Figure 4. In this example, the TVS diode has a working voltage of 22V and clamps at approximately 38V at I_{PP} = 24A at 125°C. TDS2211P clamps at approximately 27V across the rated I_{PP} range. Clamping also remains the same over the rated temperature range compared to the TVS which increases with increasing temperature.

Figure 1- Functional Diagram

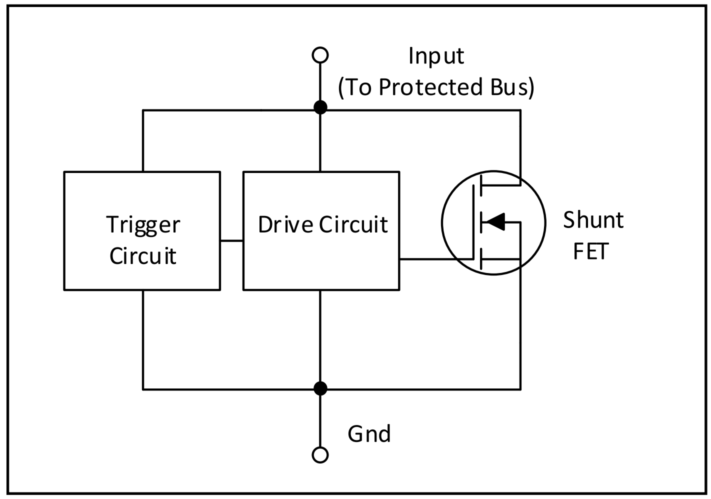


Figure 2- TDS Operation

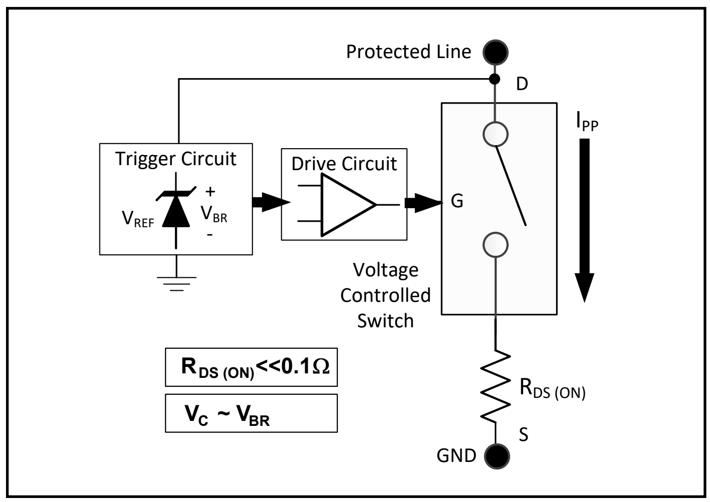
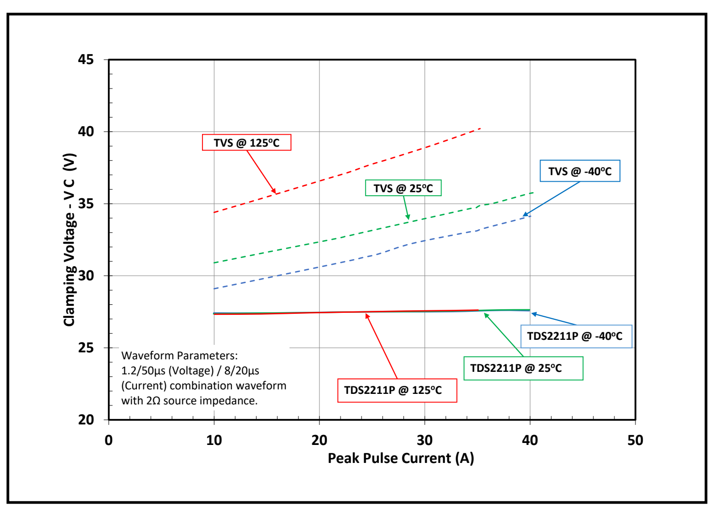


Figure 3- Clamping Comparison



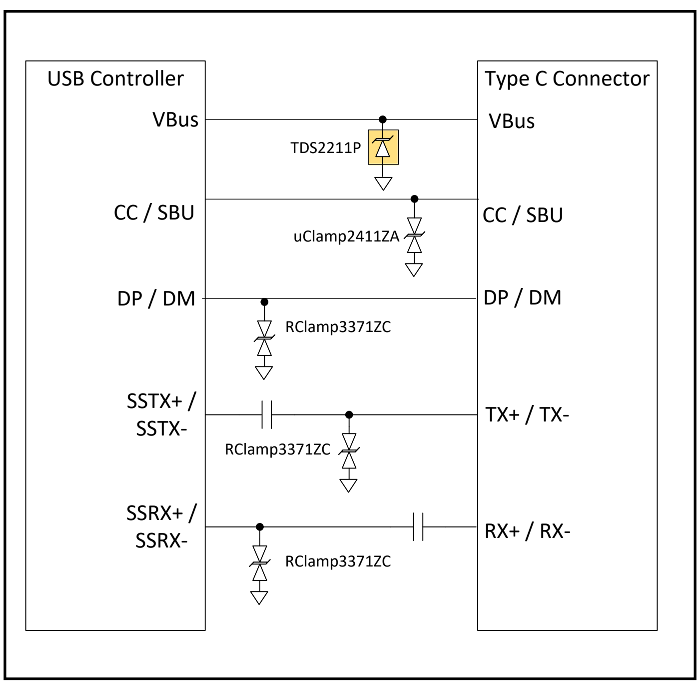
Application Information (Continued)

Typical Applications

A typical application for TDS2211P is protecting USB Type-C interfaces. A USB Type-C bus which includes power delivery (PD) can have a nominal operating voltage as high as 20V and withstand voltage up to 22V. USB PD controllers can be damaged if the voltage across the bus increases beyond its design parameters. TVS diodes are often used to protect the bus. However, designers are often forced to select devices with higher than necessary peak pulse current (I_{PP}) ratings in order to maintain a clamping voltage below the PD controller damage threshold. Additionally, since TVS clamping voltage increases with temperature, it is difficult for the designer to estimate protection capability at higher operating temperatures. TDS2211P is a more reliable solution since it maintains its low clamping voltage across the rated peak pulse current and operating temperature range.

Rounding out the Type-C interface EOS protection solution, low capacitance TVS (<0.25pF) such as RClamp3371ZC are required for the superspeed lines. RClamp3371ZC can also be used on the DP and DM lines, even though the low capacitance is not as critical. uClamp2411ZA is used for the CC and SBU lines. A 24V device is chosen to avoid damage to the TVS in case of a short to VBus.

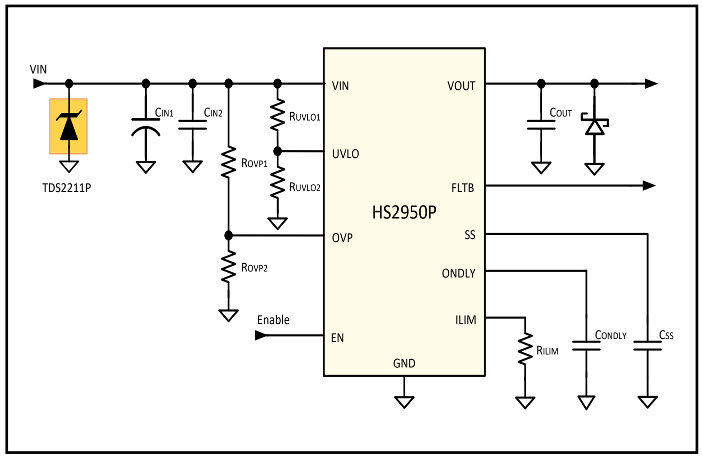
Figure 4- USB Type-C Protection Solution



Load Switch Protection

TDS2211P can also be used to protect load switch and e-fuse inputs (Figure 5) in applications such as industrial equipment, remote meters, robotics, USB PD, and IoT devices. In this case, the TDS2211P not only protects downstream components from lightning, ESD, and other EOS events, but it also protects the load switch by keeping the clamping voltage below the damage threshold of the switch's internal FET.

Figure 5 - Load Switch Input Protection

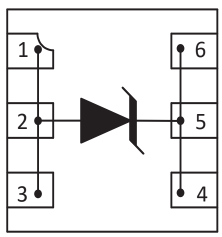


Application Information

Pin Configuration

TDS2211P is in a 1.6 x 1.6mm, 6-pin DFN package. The input or connection to the protected bus is made at pins 4, 5, and 6. Ground connection is made at pins 1, 2, and 3. All pins must be connected for maximum peak pulse current handling capability.

Figure 6 - Pin Configuration and Description



6-Pin DFN Package (Top View)

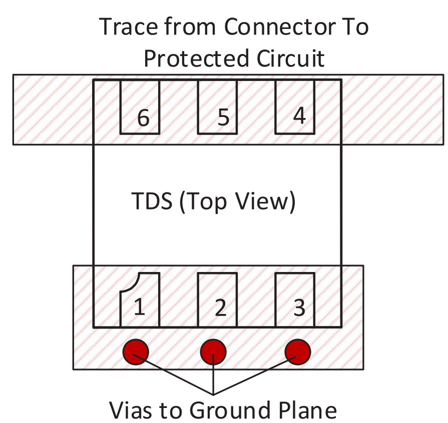
Pin Number	Pin name	Description
1,2,3	GND	Ground
4,5,6	IN	EOS and ESD Protection Input

Layout Guidelines

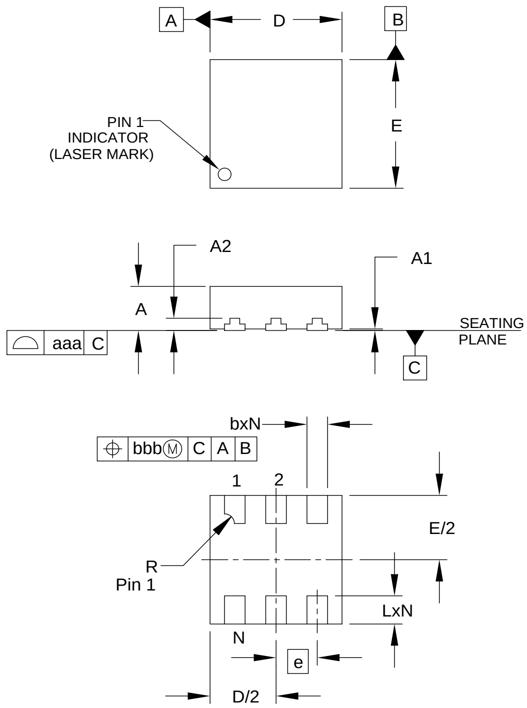
Figure 7 shows a recommended layout for TDS2211P. All the I/O pins (Pin 4, 5 and 6) are connected through a single straight trace. All of the I/O pins must be connected for maximum surge performance. Likewise, all GND pins (Pin 1, 2 and 3) must be connected for maximum surge current capability. If ground is on a different layer of the PCB, connection with multiple vias is recommended. This aids in reducing the parasitic inductance to ground. Note that under transient conditions, the energy is dissipated in the device and no "thermal pad" is needed.

TDS2211P should be located as close to the connector as possible. This aids in restricting transient coupling to adjacent traces, especially during fast rise time ESD events.

Figure 7 - PCB Layout Recommendation



Outline Drawing - DFN 1.6mm x 1.6mm x 0.55mm 6-Lead

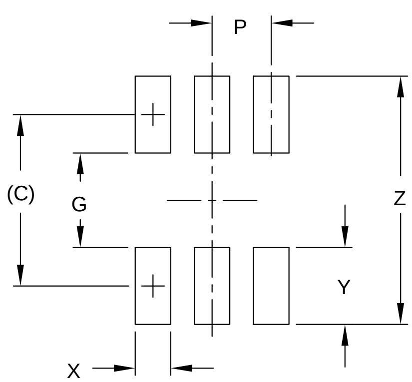


DIM	DIMENSIONS MILLIMETERS		
	MIN	NOM	MAX
A	0.50	0.55	0.60
A1	0.00	0.02	0.05
A2		(0.152)	
b	0.20	0.25	0.30
D	1.55	1.60	1.65
E	1.55	1.60	1.65
e		0.50 BSC	
L	0.30	0.35	0.40
N		6	
R	0.07	0.12	0.17
aaa		0.08	
bbb		0.10	

NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).

Land Pattern - DFN 1.6mm x 1.6mm x 0.55mm 6-Lead

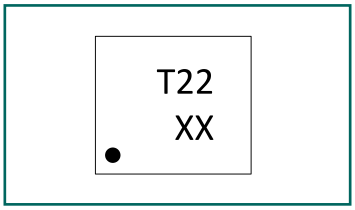


DIM	DIMENSIONS MILLIMETERS
C	(1.45)
G	0.80
P	0.50
X	0.30
Y	0.65
Z	2.10

NOTES:

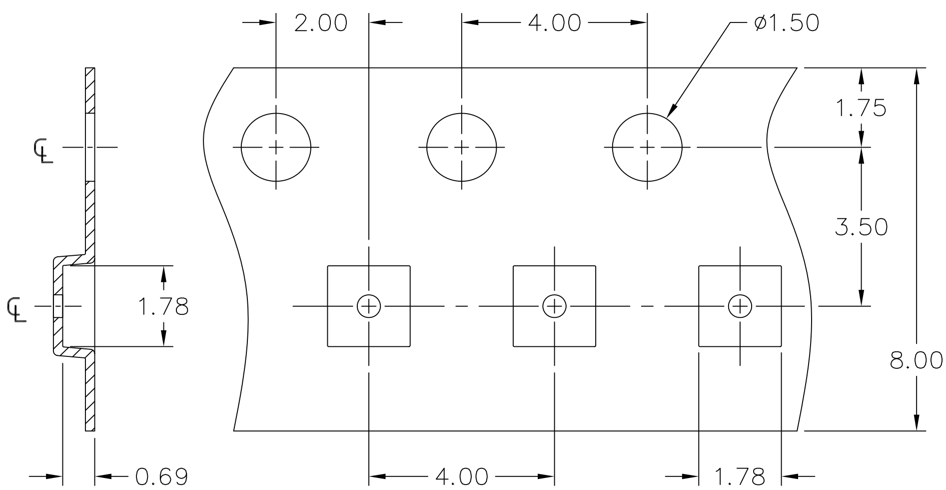
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.

Marking Code

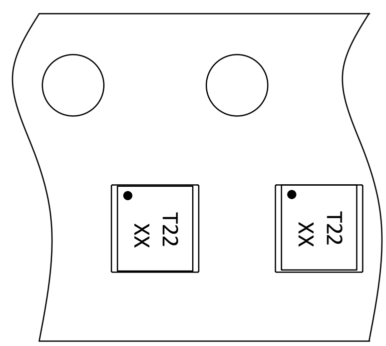


Notes:
1. XX: Date Code.
2. Dot indicates Pin 1 location.

Tape and Reel Specification



Note: All dimensions are nominal dimensions in mm.



Ordering Information

Part Number	Qty per Reel	Reel Size
TDS2211P.C	3,000	7″

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