RClamp3361P

RailClamp®
ESD and EOS Protection for Ethernet Interfaces

PROTECTION PRODUCTS

Description

RClamp®3361P is an ultra low capacitance ESD protection device specifically designed to protect high-speed Ethernet lines. It offers desirable characteristics for board level protection including fast response time, low operating and clamping voltage, and no device degradation. The device features high surge capability of 7A (tp = 8/20 µs). ESD characteristics are highlighted by low peak ESD clamping voltage, and high ESD withstand voltage (±12kV contact per IEC 61000-4-2). RClamp3361P has a typical capacitance of 0.2pF ideal for high speed lines. Each device will protect one high-speed data line operating up to 3.3 volts.

RClamp3361P is in a 2-pin SLP1006P2 package. It measures 1.0 x 0.6 mm with a nominal height of 0.5mm. The leads are finished with lead-free NiPdAu. This ultra small package design simplifies PCB layout and facilitates matching trace lengths for consistent impedance between high speed differential lines. The combination of small size, low capacitance, and high ESD surge capability makes them ideal for use in industrial and consumer applications.

Features

- ESD withstand voltage: ±15kV (air), ±12kV (contact) per IEC 61000-4-2
- High Surge Capability: 7A (tp = 8/20 µs, R_s = 2Ω) per IEC 61000-4-5
- Ultra-Low capacitance: 0.2pF Typical
- Protects one high-speed data line
- Working voltage: ±3.3V
- Low reverse leakage current: 50nA max at V_R=3.3V
- Low Insertion Loss: 0.39dB (Typical) at 5GHz
- Large operating bandwidth: 11.3 GHz
- Solid-state silicon-avalanche technology

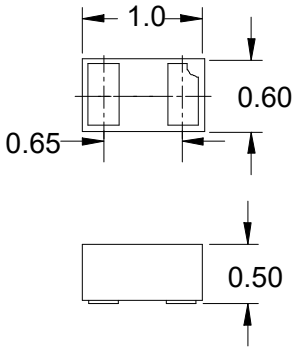
Mechanical Characteristics

- SLP1006P2 package
- Pb-Free, Halogen Free, RoHS/WEEE compliant
- Nominal Dimensions: 1.0 x 0.6 x 0.5 mm
- Lead Finish: NiPdAu
- Marking: Marking code
- Packaging: Tape and Reel

Applications

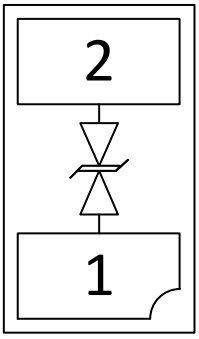
- 2.5G/5G/10GbE
- USB 3.0 and USB 3.1
- Thunderbolt
- HD-SDI

Package Dimension



Nominal Dimensions (mm)

Schematic & Pin Configuration



SLP1006P2 (Bottom View)

Absolute Maximum Rating

Rating	Symbol	Value	Units
Peak Pulse Power (tp = 8/20µs)	P_{PK}	60	W
Peak Pulse Current (tp = 8/20µs)	I_{PP}	7	A
ESD per IEC 61000-4-2 (Air)(1) ESD per IEC 61000-4-2 (Contact)(1)	V_{ESD}	±15 ±12	kV
Operating Temperature	T_J	-40 to +85	°C
Storage Temperature	T_{STG}	-55 to +150	°C

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

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	V_{RWM}	T = -40 °C to +125 °C, Pin 1 to 2 or 2 to 1				3.3	V
Reverse Breakdown Voltage	V_{BR}	I_{BR}= 1mA	T = -40°C to 85°C	5.5	7.7	9	V
Reverse Leakage Current	I_R	V_{RWM} = 3.3V	T = 25°C		<1	50	nA
			T = 85°C		<1	150	
Clamping Voltage[2]	V_C	I_{PP} = 7A, tp = 1.2/50 µs (Voltage), 8/20 µs (Current) Combination Waveform			6.5	8.5	V
ESD Clamping Voltage[3]	V_C	tp = 0.2/100ns (TLP)	I_{TLP} = 4A		4.3		V
			I_{TLP} = 16A		8.7		
Dynamic Resistance[3,4]	R_{DYN}	tp = 0.2/100ns			0.37		Ω
Junction Capacitance	C_J	V_R = 0V, f = 1MHz			0.2	0.25	pF
Cutoff Frequency	F_C	-3dB			11.3		Ghz

Notes:

1) ESD gun return path connected to ESD ground plane

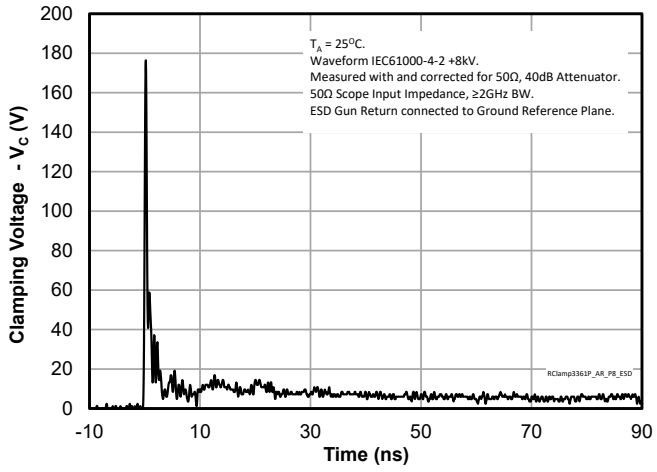
2) Measured using a 1.2/50µs voltage, 8/20µs current combination waveform, R_S = 2 Ohms. Clamping is defined as the peak voltage across the device after the device snaps back to a conducting state.

3) Transmission Line Pulse Test (TLP) Settings: tp = 100ns, tr = 0.2ns, I_{TLP} and V_{TLP} averaging window: t1 = 70ns to t2 = 90ns.

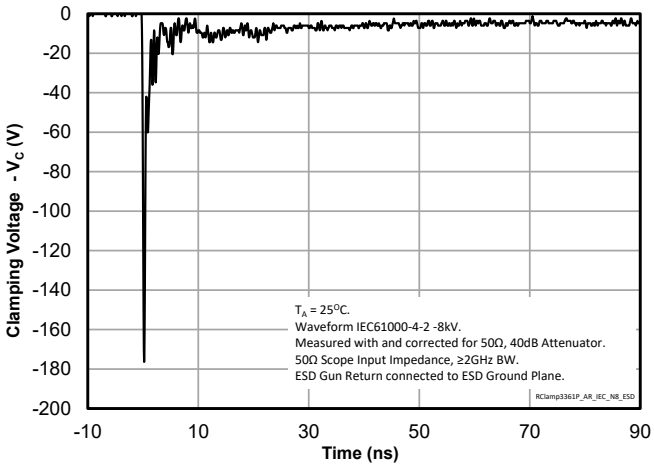
4) Dynamic resistance calculated from I_{TLP} = 4A to I_{TLP} = 16A

Typical Characteristics

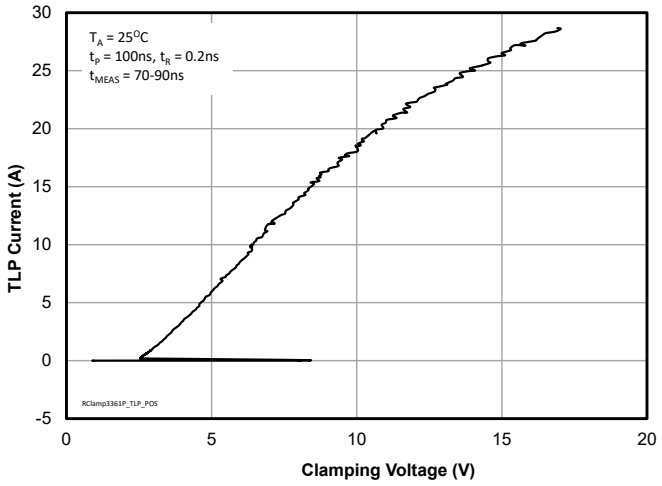
ESD Clamping (+8kV Contact per IEC 61000-4-2)



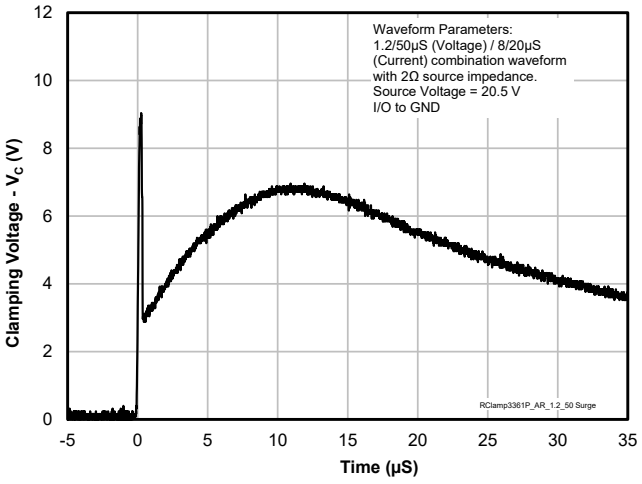
ESD Clamping (-8kV Contact per IEC 61000-4-2)



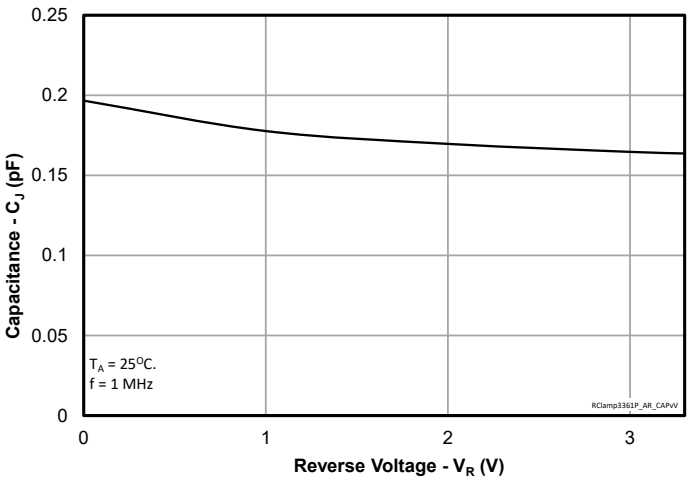
TLP Characteristic (Positive Pulse)



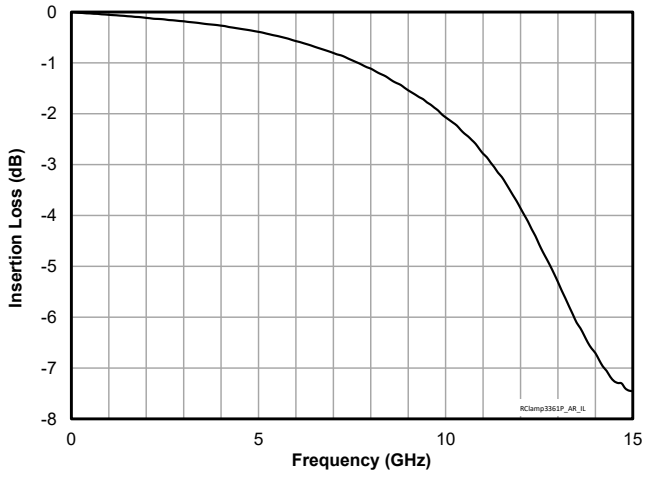
Clamping Characteristic (7A, Combination Waveform)



Capacitance vs. Reverse Voltage



Insertion Loss - S21



Application Information

Ethernet Protection

Ethernet ports are exposed to external transient events in the form of ESD, EFT, lightning, and cable discharge events (CDE). Test standards that model these events include IEC 61000-4-2 for ESD, IEC 61000-4-4 for EFT, and IEC 61000-4-5 and GR-1089 for lightning. Any of these events can cause catastrophic damage to the PHY IC.

When designing Ethernet protection, the entire system must be considered. Over-voltage events can be common mode (with respect to ground) or differential (line-to-line). An Ethernet port includes interface magnetics consisting of transformers integrated with common mode chokes. The transformer center taps are connected to ground via an RC network or "Bob Smith" termination. The purpose of this termination is to reduce common mode emissions. Note that components in the RC network should be chosen with a large enough current and voltage ratings to withstand ESD and EOS events.

The transformer provides common mode isolation to transient events, but no protection for differential surges. During a differential transient event current will flow through the transformer charging the windings on the line side. Energy is transferred to the secondary until the surge subsides or the transformer saturates.

A typical protection scheme which utilizes RClamp3361P is shown in Figure 1. Four RClamp3361P devices are located on the PHY side of the transformer. Each device will protect one line pair. When connected in this configuration the devices can protect the PHY IC from a 500V surge (tp = 1.2/50µs, R_s = 42Ω). Placing the protection on the PHY side of the magnetics is advantageous in that the magnitude and duration of the surge is attenuated by the transformer windings. The amount of attenuation will vary by vendor and configuration of the magnetics. The Ethernet transformer must be able to support the impulse tests without failure. A typical Ethernet transformer can withstand a few hundred amperes (tp=8/20us) before failure occurs, but this needs to be verified by testing.

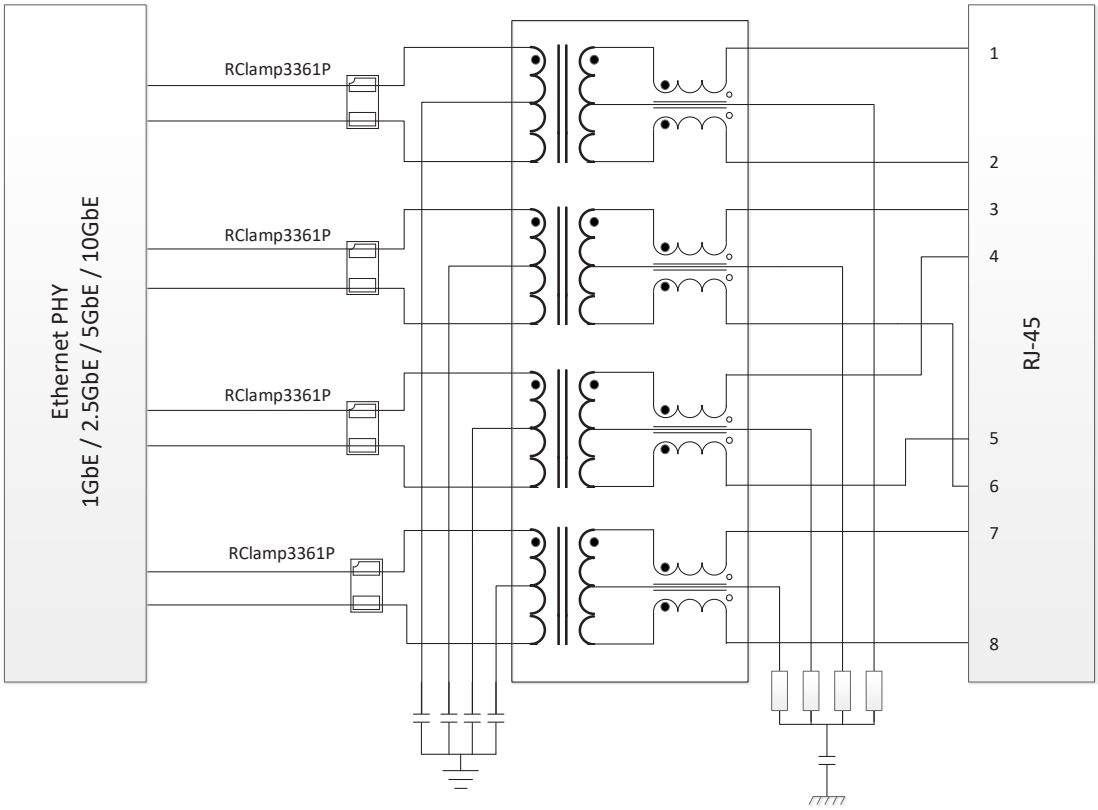


Figure 1 - Ethernet Protection Circuit

Application Information

Device Placement and Layout

Placement of the protection component is a critical element for effective transient voltage suppression. Parasitic inductance in the protection path should be minimized by locating RClamp3361P as physically close to the magnetics as possible, and preferably on the same side of the PCB. Traces can be routed straight through the device from the PHY to the magnetics, as shown in Figure 2.

Reducing parasitic inductance is especially important for suppressing fast rise time transients such as ESD and EFT. Inductance in the path of the protection device increases the peak clamping voltage seen by the protected device (V = L di/dt). For example, 1nH of inductance can increase the peak clamping voltage by 30V for a 30A (8kV) ESD pulse with a 1ns rise time.

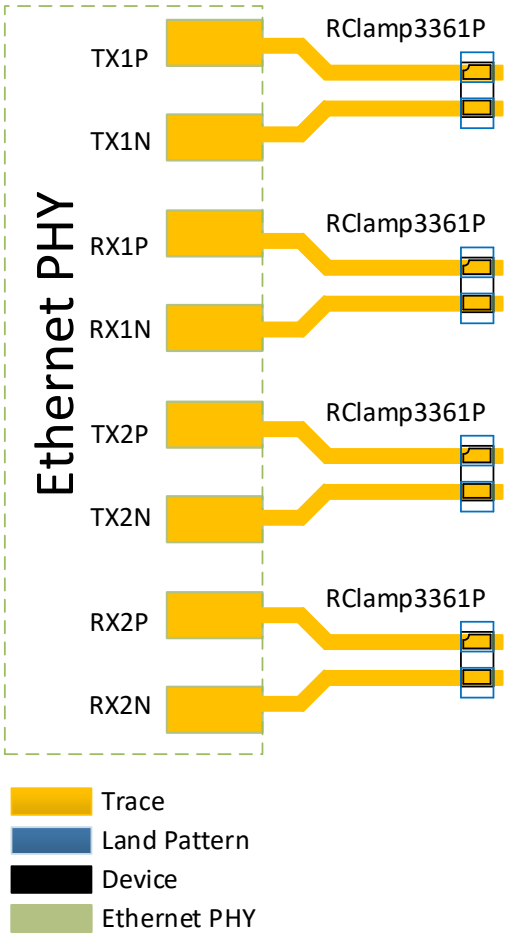
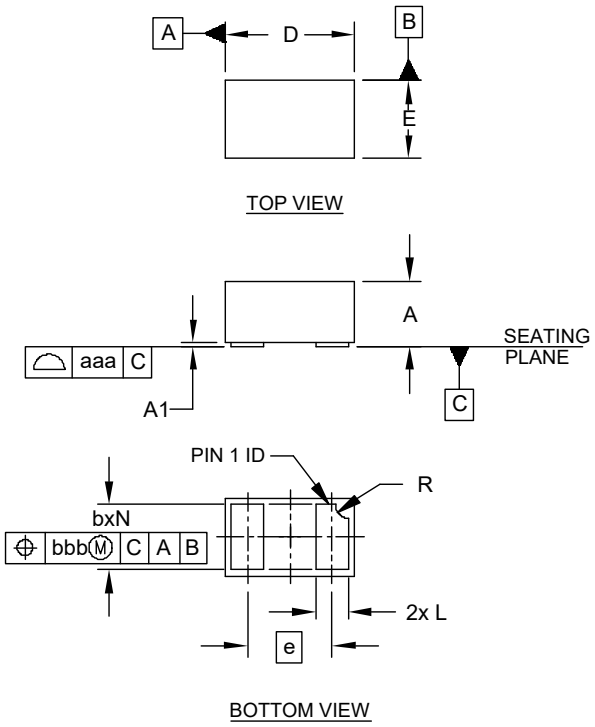


Figure 2 - Four Device Layout Example

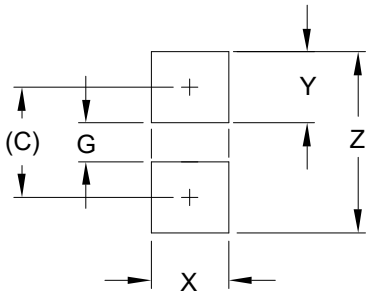
Outline Drawing - SLP1006P2



DIM	DIMENSIONS		
	MILLIMETERS		
	MIN	NOM	MAX
A	0.47	0.50	0.53
A1	0.00	0.03	0.05
b	0.45	0.50	0.55
D	0.95	1.00	1.05
E	0.55	0.60	0.65
e	0.65 BSC		
L	0.20	0.25	0.30
R	0.05	0.10	0.15
N	2		
aaa	0.08		
bbb	0.10		

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

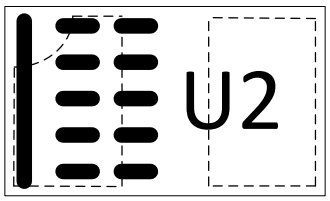
Land Pattern - SLP1006P2



DIM	DIMENSIONS
	MILLIMETERS
C	(0.85)
G	0.30
X	0.60
Y	0.55
Z	1.40

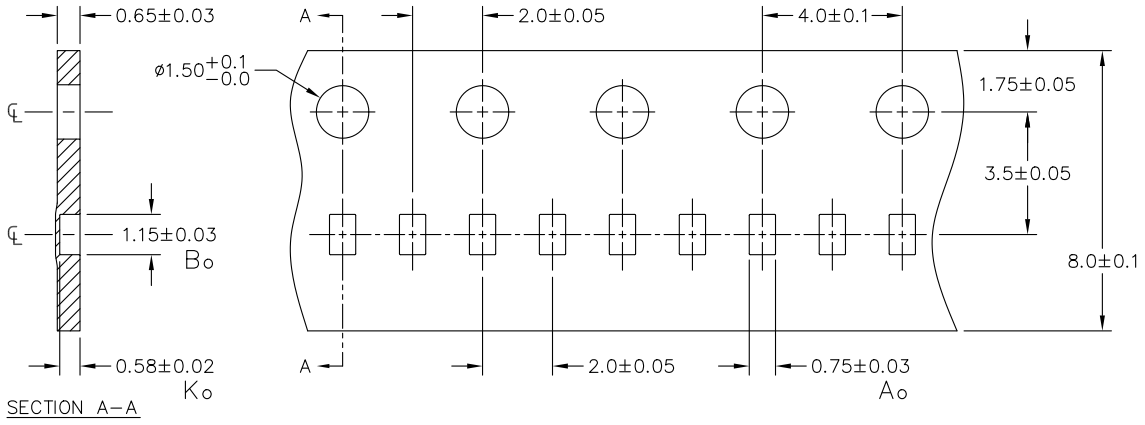
NOTES:
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.

Marking

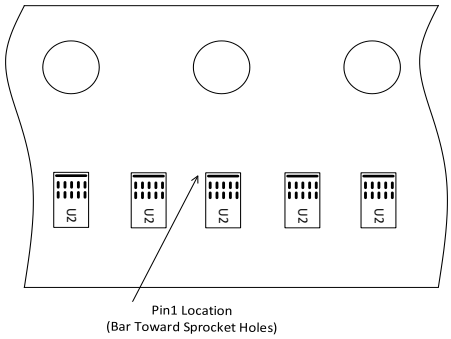


Notes:
1. Device is electrically symmetrical.
2. Marking will also include line matrix date code.
3. Bar indicates Pin 1 location

Tape and Reel Specification



NOTES: ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.



Ordering Information

Part Number	Qty per Reel	Reel Size
RClamp3361P.TFT	15,000	7″
RClamp is trademark of Semtech Corporation.		

Important Notice

Information relating to this product and the application or design described herein is believed to be reliable, however such information is provided as a guide only and Semtech assumes no liability for any errors in this document, or for the application or design described herein. Semtech reserves the right to make changes to the product or this document at any time without notice. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. Semtech warrants performance of its products to the specifications applicable at the time of sale, and all sales are made in accordance with Semtech's standard terms and conditions of sale.

SEMTECH PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS, OR IN NUCLEAR APPLICATIONS IN WHICH THE FAILURE COULD BE REASONABLY EXPECTED TO RESULT IN PERSONAL INJURY, LOSS OF LIFE OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. INCLUSION OF SEMTECH PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE UNDERTAKEN SOLELY AT THE CUSTOMER'S OWN RISK. Should a customer purchase or use Semtech products for any such unauthorized application, the customer shall indemnify and hold Semtech and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs damages and attorney fees which could arise.

Contact Information

Semtech Corporation
200 Flynn Road, Camarillo, CA 93012
Phone: (805) 498-2111, Fax: (805) 498-3804
www.semtech.com