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#### PROTECTION PRODUCTS - RailClamp®

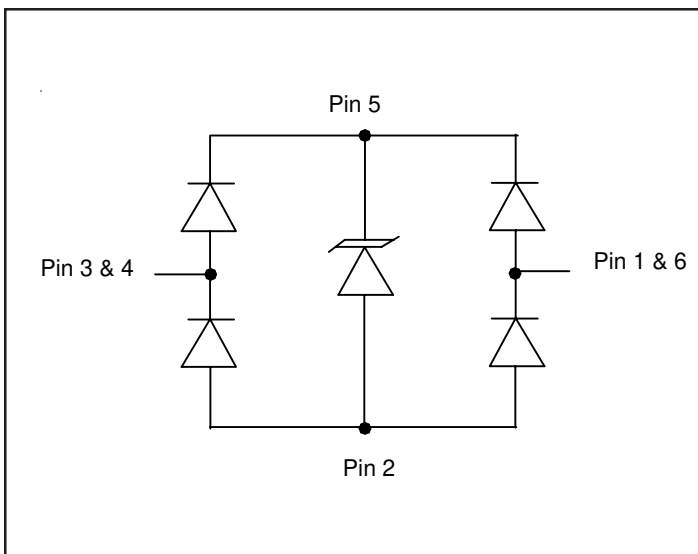
#### Description

The RailClamp® series consists of ultra low capacitance TVS arrays designed to protect high speed data interfaces. This series has been specifically designed to protect sensitive components which are connected to high-speed data and transmission lines from overvoltage caused by **ESD** (electrostatic discharge), **CDE** (Cable Discharge Events), and **EFT** (electrical fast transients). They are designed for use in applications where board space is at a premium. Each device requires less than 2.9mm<sup>2</sup> of PCB area and will protect two high speed data lines.

The monolithic design incorporates surge rated, low capacitance steering diodes and a TVS diode in a single package. Each line has a typical capacitance of 0.9pF to ground and 0.3pF between lines. The capacitance of each line is well matched for constant signal balance. Signal integrity is further preserved with the flow through design. A connection to the TVS is provided for protection of external voltage busses, such as those found in USB applications. This device is optimized for ESD protection of portable electronics. They may be used to meet the ESD immunity requirements of IEC 61000-4-2, Level 4 ( $\pm 15\text{kV}$  air,  $\pm 8\text{kV}$  contact discharge).

The RClamp0502A is in a 6-pin, RoHS/WEEE compliant, SC-89 (SOT-666) package. It measures 1.6 x 1.6 x 0.6mm. The leads are finished with lead-free matte tin. The small package makes it ideal for use in portable electronics such as cell phones, laptops, and digital still cameras.

#### Circuit Diagram



#### Features

- ◆ Transient protection for high-speed data lines to **IEC 61000-4-2 (ESD)  $\pm 15\text{kV}$  (air),  $\pm 8\text{kV}$  (contact)** **IEC 61000-4-4 (EFT) 40A (5/50ns)**
- ◆ Flow through design for ease of layout for high speed data line application
- ◆ Protects up to two I/O lines & power line
- ◆ Low capacitance (**<0.9pF**) for high-speed interfaces
- ◆ Ultra-small package requires less than 2.9mm<sup>2</sup> of PCB area
- ◆ Low leakage current and clamping voltage
- ◆ Low operating voltage: 5.0V
- ◆ Solid-state silicon-avalanche technology

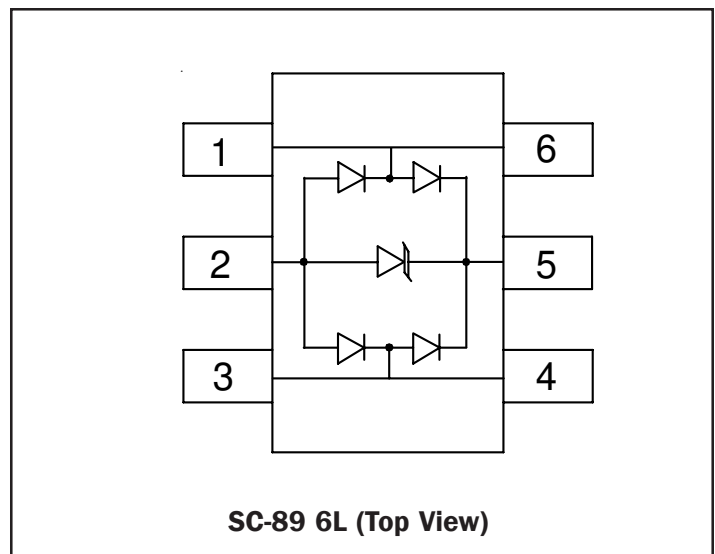
#### Mechanical Characteristics

- ◆ SC-89 (SOT-666) package
- ◆ RoHS/WEEE Compliant
- ◆ Lead Finish: matte tin
- ◆ Molding compound flammability rating: UL 94V-0
- ◆ Marking: A
- ◆ Packaging: Tape and Reel

#### Applications

- ◆ USB 2.0 High Speed
- ◆ 10/100/1000 Ethernet Ports
- ◆ High-Definition Multimedia Interface (HDMI)
- ◆ Digital Visual Interface (DVI)
- ◆ Monitors and Flat Panel Displays
- ◆ Video Graphics Cards
- ◆ IEEE 1394 Firewire Ports High Speed

#### Schematic & PIN Configuration



**PROTECTION PRODUCTS**
**Absolute Maximum Rating**

Rating	Symbol	Value	Units
Peak Pulse Power (tp = 8/20μs)	$P_{pk}$	50	Watts
Peak Pulse Current (tp = 8/20μs)	$I_{pp}$	3	A
ESD per IEC 61000-4-2 (Air) <sup>1</sup> ESD per IEC 61000-4-2 (Contact)	$V_{ESD}$	±20 ±15	kV
Operating Temperature	$T_j$	-55 to +125	°C
Storage Temperature	$T_{STG}$	-55 to +150	°C

Note 1: Between any I/O and GND

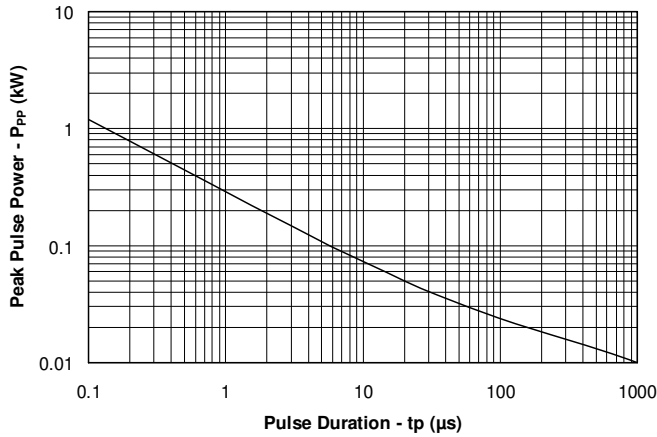
**Electrical Characteristics (T=25°C)**

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Reverse Stand-Off Voltage	$V_{RWM}$	Between I/O lines to Gnd or I/O to I/O			5	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1mA$ Between I/O lines to Gnd	6			V
Reverse Leakage Current	$I_R$	$V_{RWM} = 5V, T=25^\circ C$ Between I/O lines to Gnd or I/O to I/O			1	μA
Clamping Voltage	$V_C$	$I_{pp} = 1A, tp = 8/20\mu s$ Between I/O lines to Gnd			14	V
Clamping Voltage	$V_C$	$I_{pp} = 3A, tp = 8/20\mu s$ Between I/O to Gnd			16	V
Clamping Voltage	$V_C$	$I_{pp} = 3A, tp = 8/20\mu s$ Between I/O to I/O			18	V
Junction Capacitance	$C_j$	$V_R = 0V, f = 1MHz$ Between I/O to Gnd			0.9	pF
Junction Capacitance	$C_j$	$V_R = 0V, f = 1MHz$ Between I/O to I/O		0.3	0.7	pF

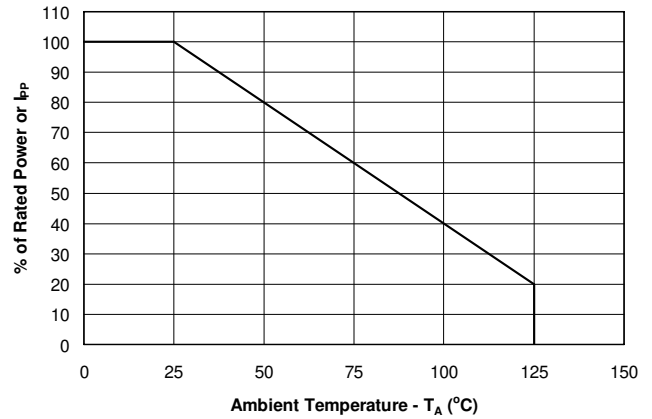
PROTECTION PRODUCTS

Typical Characteristics

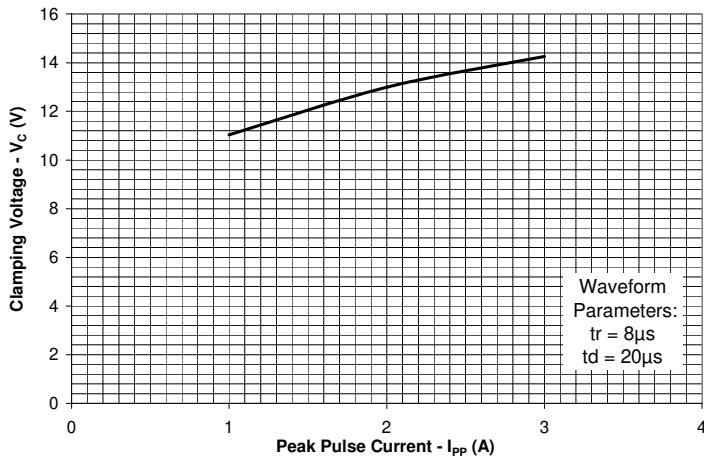
Non-Repetitive Peak Pulse Power vs. Pulse Time



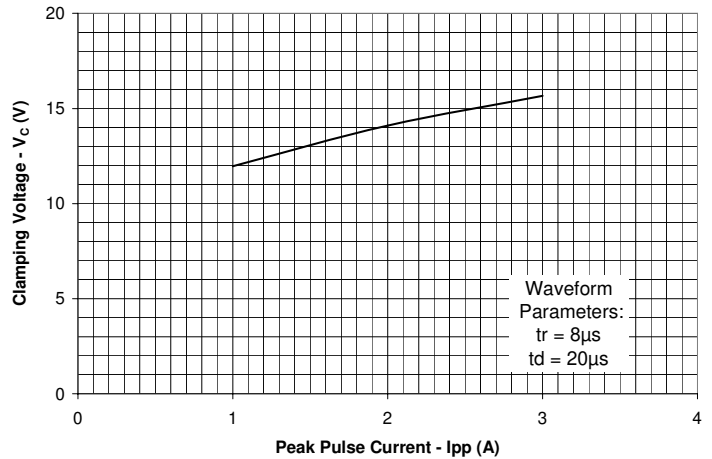
Power Derating Curve



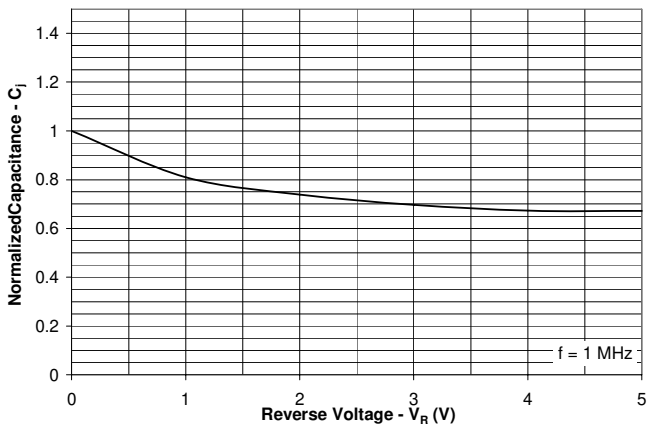
Clamping Voltage vs. Peak Pulse Current  
I/O to Gnd - Pin 1, 3, 4, 6 to Pin 2



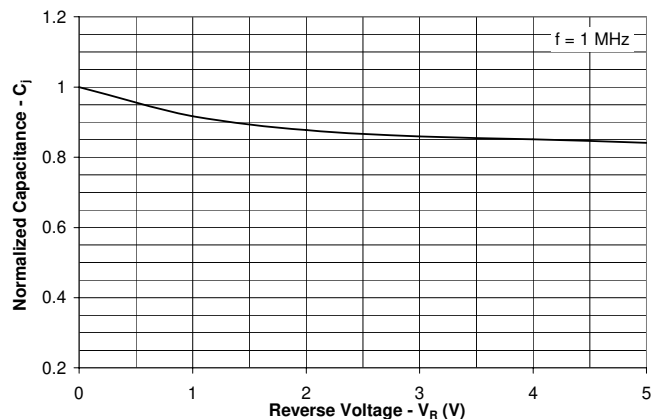
Clamping Voltage vs. Peak Pulse Current  
I/O to I/O



Normalized Capacitance vs. Reverse Voltage  
I/O to Gnd - Pin 1, 3, 4, or 6 to Pin 2



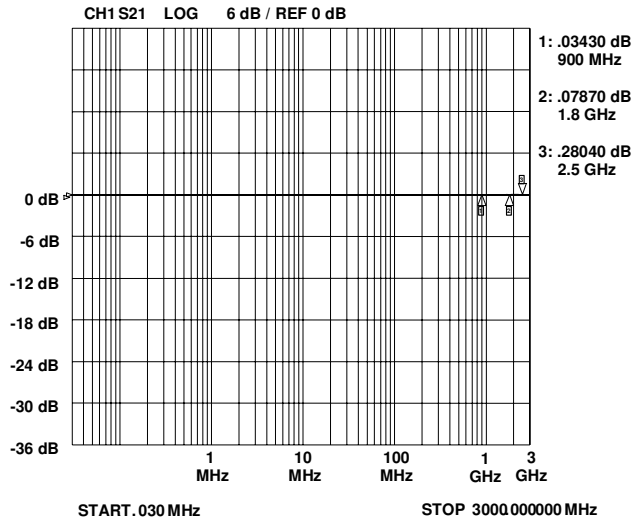
Normalized Capacitance vs. Reverse Voltage  
I/O to I/O



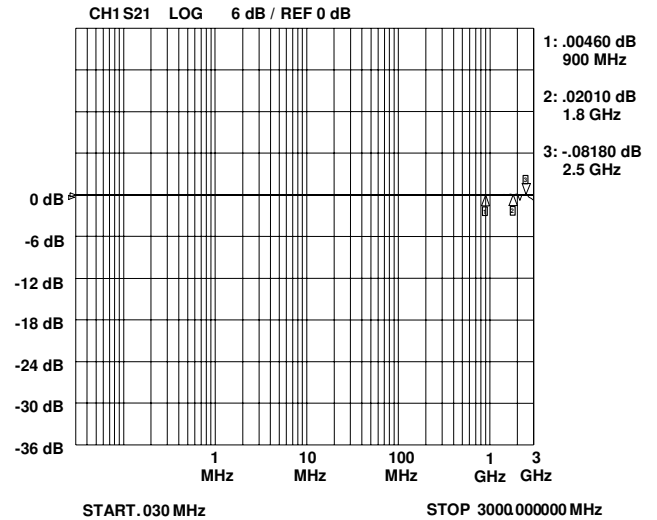
## PROTECTION PRODUCTS

### Typical Characteristics

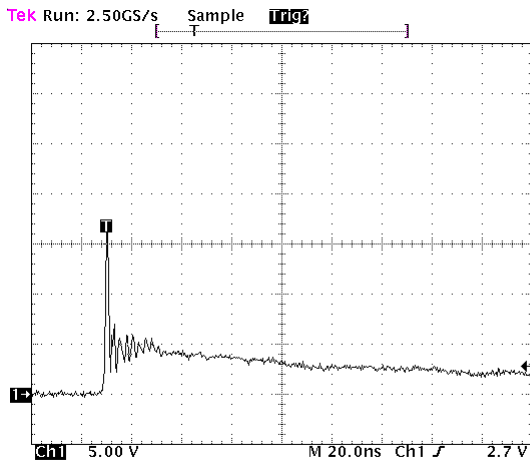
**Insertion Loss S21 (I/O to I/O)**



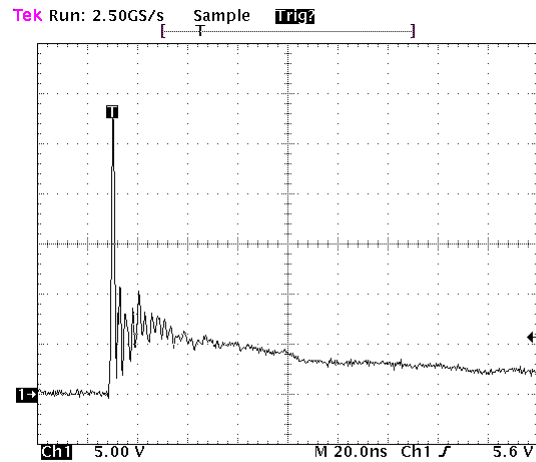
**Insertion Loss S21 (I/O to Gnd)**



**ESD Response (4kV Contact per IEC 61000-4-2)**



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



Note: Data is taken with a 10x attenuator

Note: Data is taken with a 10x attenuator

## PROTECTION PRODUCTS

### Applications Information

#### Device Connection Options for Protection of Two High-Speed Data Lines

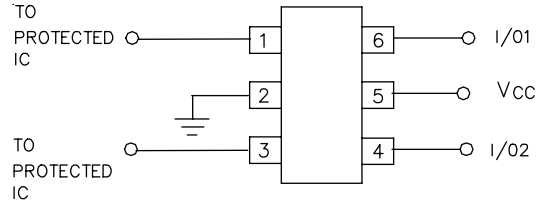
This device is designed to protect data lines by clamping them to a fixed reference. When the voltage on the protected line exceeds the reference voltage the steering diodes are forward biased, conducting the transient current away from the sensitive circuitry. Data lines are connected at pins 1 & 6 and pins 3 & 4. Pins 5 and 2 can be connected to ground or Vcc based on application and location of those connections. The connection to ground should be made directly to a ground plane. The path length should also be kept as short as possible to minimize parasitic inductance. Figure 1 shows the layout configuration to send data input at pins 6 and 4 and output at pins 1 and 3.

This device is designed for ease of PCB layout by allowing the traces run straight through the device. Figure 2 shows the proper way to design the PCB board trace in order to use the flow through layout for two line pairs. The solid line represents the PCB trace. Note the PCB traces are used to connect the pin pairs for each I/O (pin 1 to pin 6 and pins 3 to pin 4). For example, I/O 1 enters at pin 6 and exits at pin 1 and the PCB trace connects pins 6 and 1 together. This is also true for I/O 2. The negative reference (Gnd) is connected at pin 2. The positive reference is connected at pin 5.

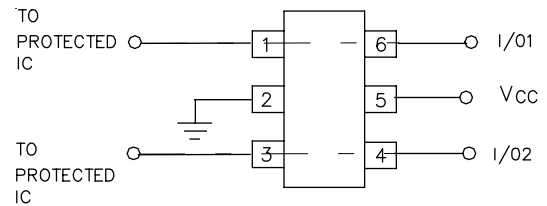
#### Universal Serial Bus ESD Protection

The RClamp0502A may also be used to protect both upstream and downstream USB ports on monitors, computers, peripherals or portable systems. Each device will protect up to one USB port (Figure 3). When the voltage on the data lines exceed the bus voltage (plus one diode drop), the internal rectifiers are forward biased conducting the transient current away from the protected controller chip. The TVS diode directs the surge to ground. The TVS diode also acts to suppress ESD strikes directly on the voltage bus. Thus, both power and data pins are protected with a single device.

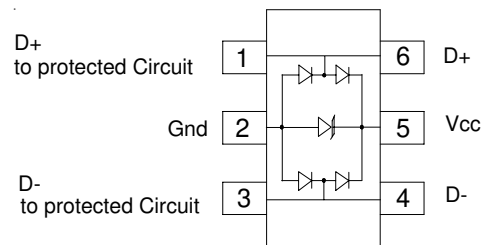
**Figure 1. Protection of Two Data Lines and One Power Supply Line**



**Figure 2. Flow Through Layout for Two Data Lines and one Power Line**

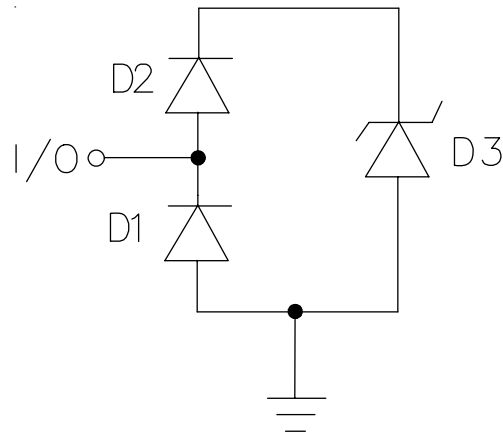


**Figure 3. USB 2.0 (up to 480Mbps) Upstream or Downstream Port Protection**



PROTECTION PRODUCTS

Applications Information - Spice Model

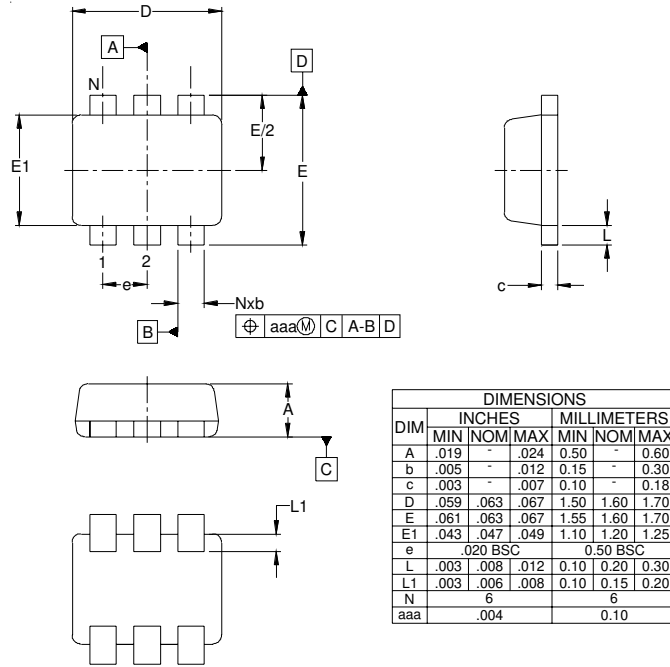


RClamp0502A Spice Model

Table 1 - RClamp0502A Spice Parameters				
Parameter	Unit	D1 (LCRD)	D2 (LCRD)	D3 (TVS)
IS	Amp	1E-20	1E-20	2.43E-13
BV	Volt	110	20	8
VJ	Volt	0.67	0.67	0.64
RS	Ohm	0.339	0.568	1.24
IBV	Amp	1E-3	1E-3	1E-3
CJO	Farad	0.7E-12	0.7E-12	83E-12
TT	sec	2.541E-9	2.541E-9	2.541E-9
M	--	0.01	0.01	0.222
N	--	1.1	1.1	1.1
EG	eV	1.11	1.11	1.11

PROTECTION PRODUCTS

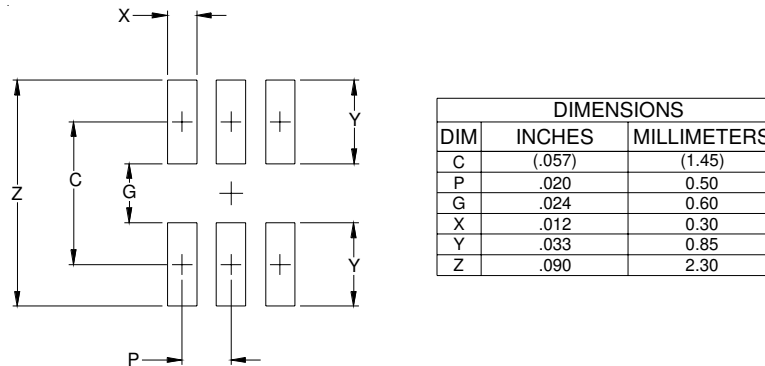
Outline Drawing - SC-89 (SOT-666)



NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. DIMENSIONS "E1" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

Land Pattern - SC-89 (SOT-666)



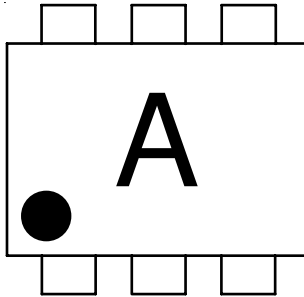
NOTES:

1. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.



## PROTECTION PRODUCTS

### Marking

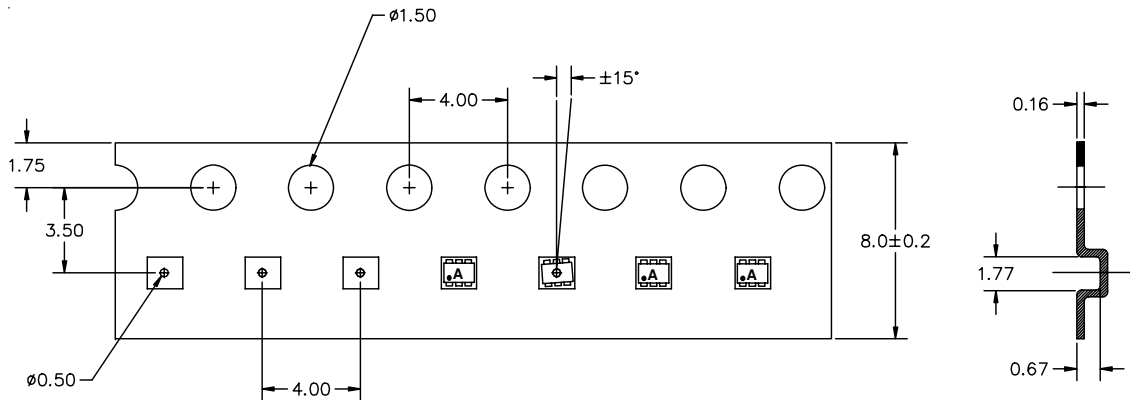


### Ordering Information

Part Number	Lead Finish	Qty per Reel	Reel Size
RClamp0502A.TCT	Pb Free	3,000	7 Inch

RailClamp and RClamp are registered marks of Semtech Corporation

### Tape and Reel Specification



☐ DIMENSIONS ARE IN MILLIMETERS.

☐ SAME AS 3M US046041.

### Tape Specification and Device Orientation

### Contact Information

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