

## PROTECTION PRODUCTS

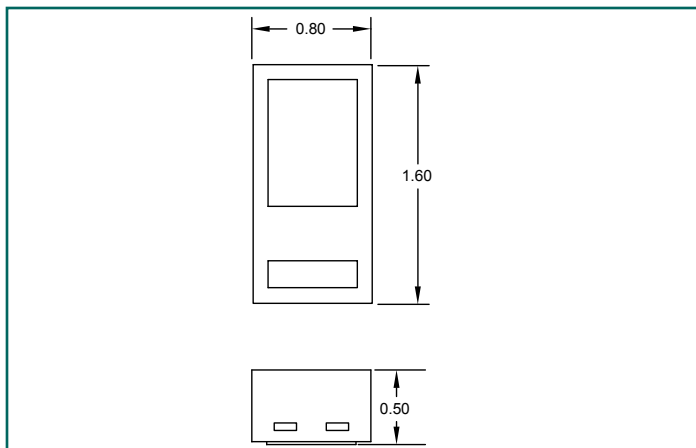
### Description

μClamp® TVS diodes are designed to protect sensitive electronics from damage or latch-up due to EOS, lightning, CDE, and ESD. They feature large cross-sectional area junctions for conducting high transient currents. These devices offer desirable characteristics for board level protection including fast response time, low operating and clamping voltage, and no device degradation.

μClamp®xx61P series are designed for use in harsh transient environments. They feature extremely good protection characteristics highlighted by high surge current capability, low peak ESD clamping voltage, and high ESD withstand voltage. Device options are available for protecting data or power lines operating at 5V to 60V.

μClamp®xx61P are in a 2-pin SLP1608P2 package measuring 1.6 x 0.8 mm with a nominal height of 0.50mm. The leads are finished with lead-free NiPdAu. High surge current capability and low clamping voltage making them ideal for protecting VBus, battery, and other power lines in consumer and industrial electronics.

### Package Dimension



### Features

- Transient Protection to
  - ♦ IEC 61000-4-2 (ESD) 30kV (Air), 30kV (Contact)
  - ♦ IEC 61000-4-4 (EFT) 4kV (5/50ns)
  - ♦ IEC 61000-4-5 (Lightning) 8-80A (8/20μs)
- Protects one data or power line
- Working voltage options: 5V, 10V, 12V, 15V, 24V, 30V, 36V, 40V, 60V
- Low leakage current
- High peak pulse current capability
- Solid-state silicon-avalanche technology

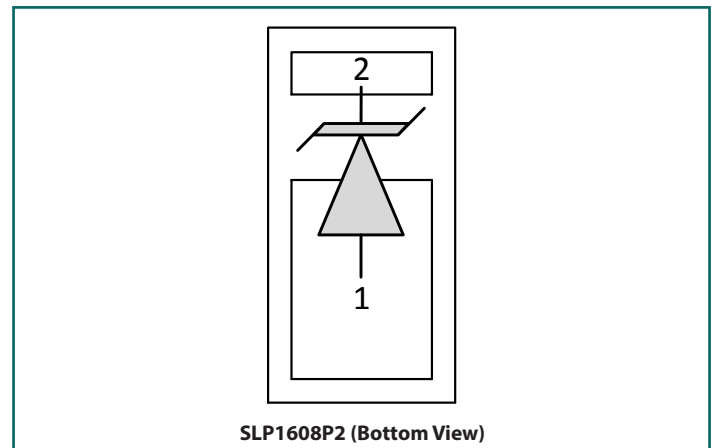
### Mechanical Characteristics

- SLP1608P2 package
- Pb-Free, Halogen Free, RoHS/WEEE compliant
- Nominal Dimensions: 1.6 x 0.8 x 0.50 mm
- Lead Finish: NiPdAu
- Marking: Marking code
- Packaging: Tape and Reel

### Applications

- Cellular Handsets
- Industrial Equipment
- Microcontroller RESET and IRQ Pins
- USB Voltage Bus
- Battery protection
- Tablet PC
- CCTV Cameras
- Instrumentation

### Schematic & Pin Configuration



## Absolute Maximum Ratings

Rating	Symbol	Value	Units
Peak Pulse Power ( $t_p = 8/20\mu s$ )	$P_{PK}$	1200-1600	W
Peak Pulse Current ( $t_p = 8/20\mu s$ )	$I_{PP}$	8-80	A
ESD per IEC 61000-4-2 (Contact) <sup>(1)</sup> ESD per IEC 61000-4-2 (Air) <sup>(1)</sup>	$V_{ESD}$	$\pm 30$ $\pm 30$	kV
Operating Temperature	$T_J$	-40 to +125	°C
Storage Temperature	$T_{STG}$	-55 to +150	°C

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

<b>μClamp0561P</b>						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	$V_{RWM}$	-40°C to 125°C, Pin 2 to Pin 1			5	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1mA$ , Pin 2 to Pin 1	6	7	9	V
Reverse Leakage Current	$I_R$	$V_{RWM} = 5V$ $T = 25^\circ C$		50	300	nA
Peak Pulse Current	$I_{PP}$	$t_p = 8/20\mu s$			80	A
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 40A$ , $t_p = 8/20\mu s$ , Pin 2 to Pin 1			12	V
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 80A$ , $t_p = 8/20\mu s$ , Pin 2 to Pin 1			15	V
Dynamic Resistance <sup>(3), (4)</sup>	$R_{DYN}$	$t_p = 0.2/100ns$ (TLP), Pin 2 to Pin 1		0.05		Ohms
Junction Capacitance	$C_J$	$V_R = 0V$ , $f = 1MHz$ Pin 2 to Pin 1 $T = 25^\circ C$			800	pF

Notes:

(1): ESD Gun return path to Ground Reference Plane (GRP)

(2): Tested using a constant current source

(3): Transmission Line Pulse Test (TLP) Settings:  $t_p = 100ns$ ,  $t_r = 0.2ns$ ,  $I_{TLP}$  and  $V_{TLP}$  averaging window:  $t_1 = 70ns$  to  $t_2 = 90ns$ .

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

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

<b>μClamp1061P</b>						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	$V_{RWM}$	-40°C to 125°C, Pin 2 to Pin 1			10	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1\text{ mA}$ , Pin 2 to Pin 1	12	13.5	15.5	V
Reverse Leakage Current	$I_R$	$V_{RWM} = 10\text{ V}$ $T = 25^\circ\text{C}$		<10	100	nA
Peak Pulse Current	$I_{PP}$	$t_p = 8/20\mu\text{s}$			60	A
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 10\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			17	V
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 60\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			25	V
Dynamic Resistance <sup>(3), (4)</sup>	$R_{DYN}$	$t_p = 0.2/100\text{ ns}$ (TLP), Pin 2 to Pin 1		0.05		Ohms
Junction Capacitance	$C_J$	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ Pin 2 to Pin 1 $T = 25^\circ\text{C}$			350	pF

<b>μClamp1261P</b>						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	$V_{RWM}$	-40°C to 125°C, Pin 2 to Pin 1			12	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1\text{ mA}$ , Pin 2 to Pin 1	14	16.5	19	V
Reverse Leakage Current	$I_R$	$V_{RWM} = 12\text{ V}$ $T = 25^\circ\text{C}$		<10	100	nA
Peak Pulse Current	$I_{PP}$	$t_p = 8/20\mu\text{s}$			45	A
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 10\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			25	V
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 45\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			33	V
Dynamic Resistance <sup>(3), (4)</sup>	$R_{DYN}$	$t_p = 0.2/100\text{ ns}$ (TLP), Pin 2 to Pin 1		0.05		Ohms
Junction Capacitance	$C_J$	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ Pin 2 to Pin 1 $T = 25^\circ\text{C}$			275	pF

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

<b>μClamp1561P</b>						
<b>Parameter</b>	<b>Symbol</b>	<b>Conditions</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	<b>Units</b>
Reverse Stand-Off Voltage	$V_{RWM}$	-40°C to 125°C, Pin 2 to Pin 1			15	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1\text{ mA}$ , Pin 2 to Pin 1	17.5	20	23	V
Reverse Leakage Current	$I_R$	$V_{RWM} = 15\text{ V}$ $T = 25^\circ\text{C}$		<10	100	nA
Peak Pulse Current	$I_{PP}$	$t_p = 8/20\mu\text{s}$			40	A
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 10\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			28	V
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 40\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			40	V
Dynamic Resistance <sup>(3), (4)</sup>	$R_{DYN}$	$t_p = 0.2/100\text{ ns}$ (TLP), Pin 2 to Pin 1		0.05		Ohms
Junction Capacitance	$C_J$	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ Pin 2 to Pin 1 $T = 25^\circ\text{C}$			220	pF

<b>μClamp2461P</b>						
<b>Parameter</b>	<b>Symbol</b>	<b>Conditions</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	<b>Units</b>
Reverse Stand-Off Voltage	$V_{RWM}$	-40°C to 125°C, Pin 2 to Pin 1			24	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1\text{ mA}$ , Pin 2 to Pin 1	27	32	36	V
Reverse Leakage Current	$I_R$	$V_{RWM} = 24\text{ V}$ $T = 25^\circ\text{C}$		<10	100	nA
Peak Pulse Current	$I_{PP}$	$t_p = 8/20\mu\text{s}$			23	A
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 10\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			50	V
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 23\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			65	V
Dynamic Resistance <sup>(3), (4)</sup>	$R_{DYN}$	$t_p = 0.2/100\text{ ns}$ (TLP), Pin 2 to Pin 1		0.20		Ohms
Junction Capacitance	$C_J$	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ Pin 2 to Pin 1 $T = 25^\circ\text{C}$			165	pF

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

μClamp3061P						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	$V_{RWM}$	-40°C to 125°C, Pin 2 to Pin 1			30	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1\text{ mA}$ , Pin 2 to Pin 1	34	40	42	V
Reverse Leakage Current	$I_R$	$V_{RWM} = 30\text{ V}$ $T = 25^\circ\text{C}$		<10	100	nA
Peak Pulse Current	$I_{PP}$	$t_p = 8/20\mu\text{s}$			18	A
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 10\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			55	V
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 18\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			65	V
Dynamic Resistance <sup>(3), (4)</sup>	$R_{DYN}$	$t_p = 0.2/100\text{ ns}$ (TLP), Pin 2 to Pin 1		0.25		Ohms
Junction Capacitance	$C_J$	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ Pin 2 to Pin 1 $T = 25^\circ\text{C}$			155	pF

μClamp3661P						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	$V_{RWM}$	-40°C to 125°C, Pin 2 to Pin 1			36	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1\text{ mA}$ , Pin 2 to Pin 1	37	40	44	V
Reverse Leakage Current	$I_R$	$V_{RWM} = 36\text{ V}$ $T = 25^\circ\text{C}$		<10	100	nA
Peak Pulse Current	$I_{PP}$	$t_p = 8/20\mu\text{s}$			18	A
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 2\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			48	V
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 18\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			70	V
Dynamic Resistance <sup>(3), (4)</sup>	$R_{DYN}$	$t_p = 0.2/100\text{ ns}$ (TLP), Pin 2 to Pin 1		0.25		Ohms
Junction Capacitance	$C_J$	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ Pin 2 to Pin 1 $T = 25^\circ\text{C}$			150	pF

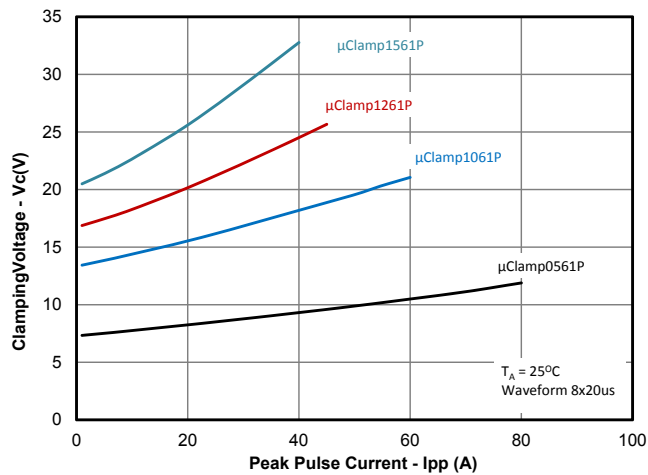
## Electrical Characteristics (T=25°C unless otherwise specified)

μClamp4061P						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	$V_{RWM}$	-40°C to 125°C, Pin 2 to Pin 1			40	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1\text{ mA}$ , Pin 2 to Pin 1	45	50	55	V
Reverse Leakage Current	$I_R$	$V_{RWM} = 40\text{ V}$ $T = 25^\circ\text{C}$		<10	100	nA
Peak Pulse Current	$I_{PP}$	$t_p = 8/20\mu\text{s}$			12	A
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 12\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			80	V
Dynamic Resistance <sup>(3), (4)</sup>	$R_{DYN}$	$t_p = 0.2/100\text{ ns}$ (TLP), Pin 2 to Pin 1		0.35		Ohms
Junction Capacitance	$C_J$	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ Pin 2 to Pin 1 $T = 25^\circ\text{C}$			125	pF

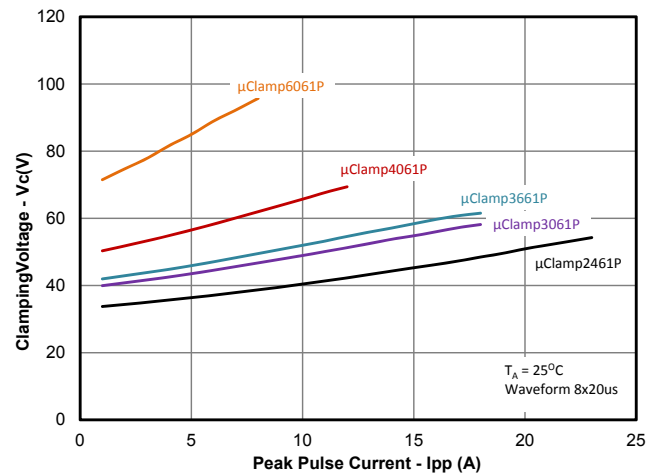
μClamp6061P						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Reverse Stand-Off Voltage	$V_{RWM}$	-40°C to 125°C, Pin 2 to Pin 1			60	V
Reverse Breakdown Voltage	$V_{BR}$	$I_t = 1\text{ mA}$ , Pin 2 to Pin 1	65	70	85	V
Reverse Leakage Current	$I_R$	$V_{RWM} = 60\text{ V}$ $T = 25^\circ\text{C}$		<10	100	nA
Peak Pulse Current	$I_{PP}$	$t_p = 8/20\mu\text{s}$			8	A
Clamping Voltage <sup>(2)</sup>	$V_C$	$I_{PP} = 8\text{ A}$ , $t_p = 8/20\mu\text{s}$ , Pin 2 to Pin 1			105	V
Dynamic Resistance <sup>(3), (4)</sup>	$R_{DYN}$	$t_p = 0.2/100\text{ ns}$ (TLP) Pin 2 to Pin 1		0.45		Ohms
Junction Capacitance	$C_J$	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ Pin 2 to Pin 1 $T = 25^\circ\text{C}$			110	pF

# Typical Characteristics

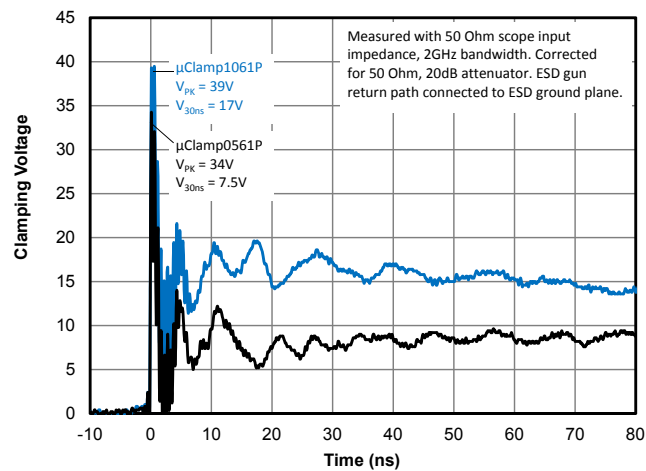
Clamping Voltage vs. Peak Pulse Current ( $V_{RWM} = 5V - 15V$ )



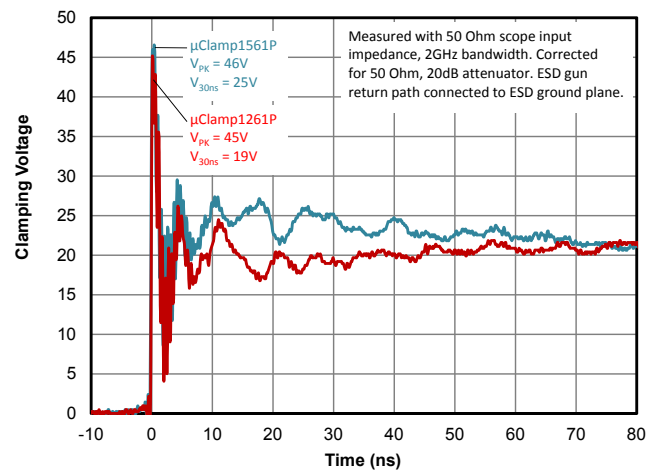
Clamping Voltage vs. Peak Pulse Current ( $V_{RWM} = 24V - 60V$ )



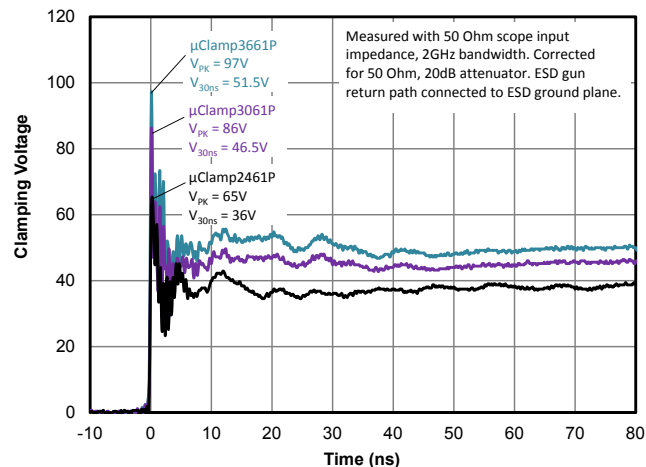
ESD Clamping (8kV Contact per IEC 61000-4-2)



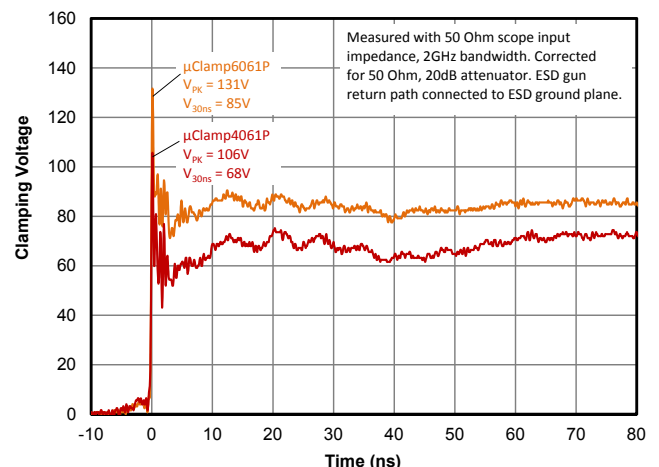
ESD Clamping (8kV Contact per IEC 61000-4-2)



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

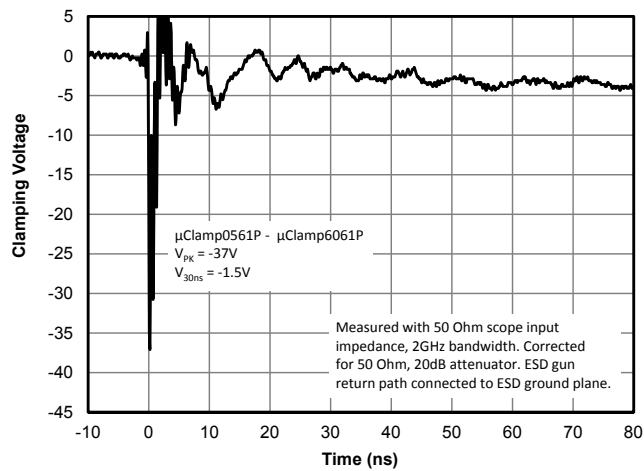


ESD Clamping (8kV Contact per IEC 61000-4-2)

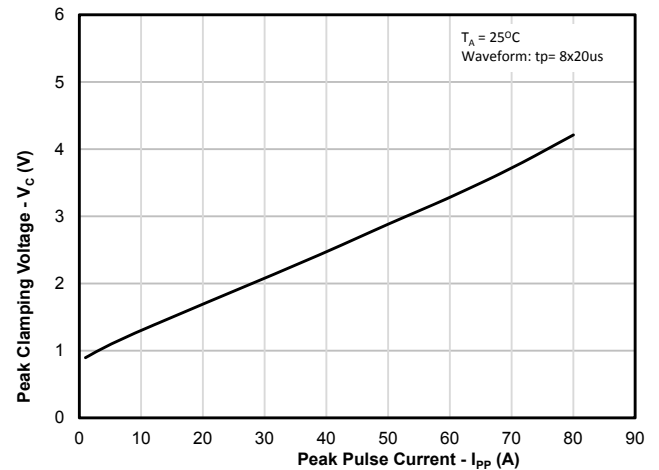


# Typical Characteristics

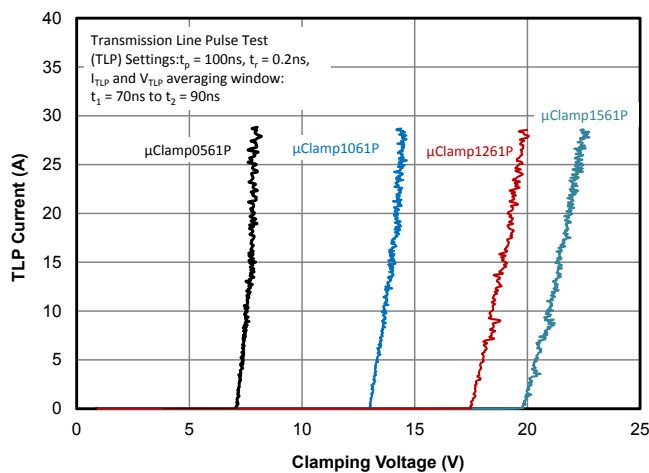
ESD Clamping (-8kV Contact per IEC 61000-4-2)



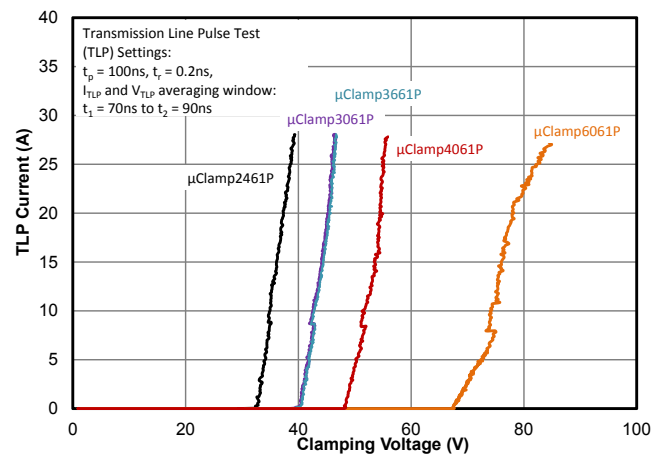
Forward Voltage vs. Peak Pulse Current ( $V_{RWM} = 5V - 60V$ )



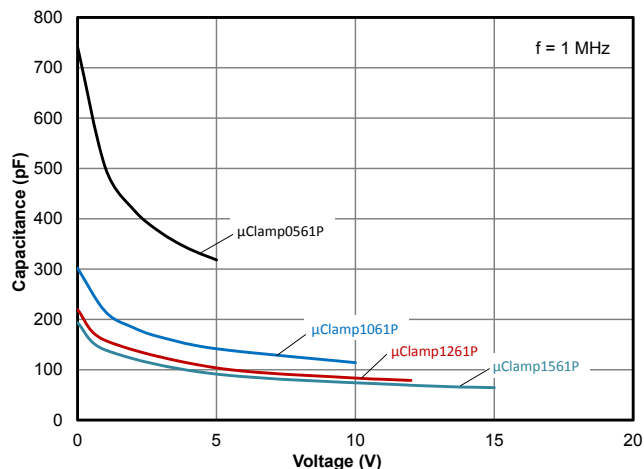
TLP Characteristic (Positive Pulse) - ( $V_{RWM} = 5V - 15V$ )



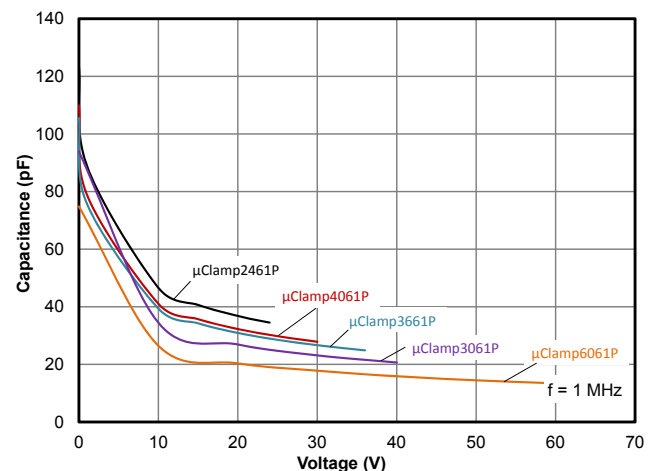
TLP Characteristic (Positive Pulse) - ( $V_{RWM} = 24V - 60V$ )



Capacitance vs. Reverse Voltage - ( $V_{RWM} = 5V - 15V$ )



Capacitance vs. Reverse Voltage - ( $V_{RWM} = 24V - 60V$ )



# Application Information

## Assembly Guidelines

The figure at the right details Semtech’s recommended mounting pattern. Recommended assembly guidelines are shown in Table 1. Note that these are only recommendations and should serve only as a starting point for design since there are many factors that affect the assembly process. Exact manufacturing parameters will require some experimentation to get the desired solder application. Semtech’s recommended mounting pattern is based on the following design guidelines:

### Land Pattern

The recommended land pattern follows IPC standards and is designed for maximum solder coverage. Detailed dimensions are shown elsewhere in this document.

### Solder Stencil

Stencil design is one of the key factors which will determine the volume of solder paste deposited onto the land pad. The area ratio of the stencil aperture will determine how well the stencil will print. The area ratio takes into account the aperture shape, aperture size, and stencil thickness. An area ratio of 0.70 – 0.75 is preferred for the subject package. The area ratio of a rectangular aperture is given as:

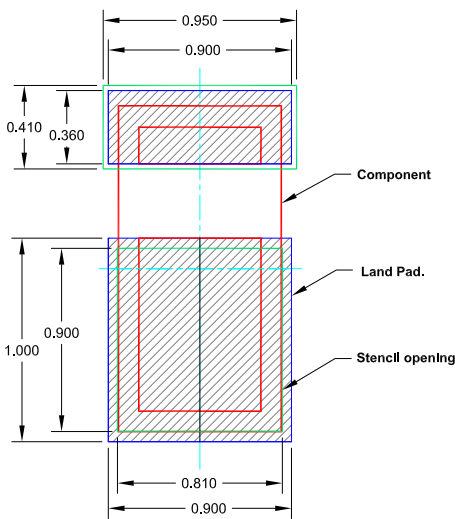
$$\text{Area Ratio} = (L * W) / (2 * (L + W) * T)$$

Where:

- L = Aperture Length
- W = Aperture Width
- T = Stencil Thickness

Semtech recommends a stencil thickness of 0.125mm for this device. The stencil should be laser cut with electro-polished finish. The stencil should have a positive taper of approximately 5 degrees. Electro polishing and tapering the walls results in reduced surface friction and better paste release. Since this device has uneven pad sizes, the recommended stencil opening is 10% smaller than the size of the large pad and 25um larger than the size of the small pad. This is done to control solder height and keep the part planar during reflow. Solder paste with Type 3 or smaller particles are recommended.

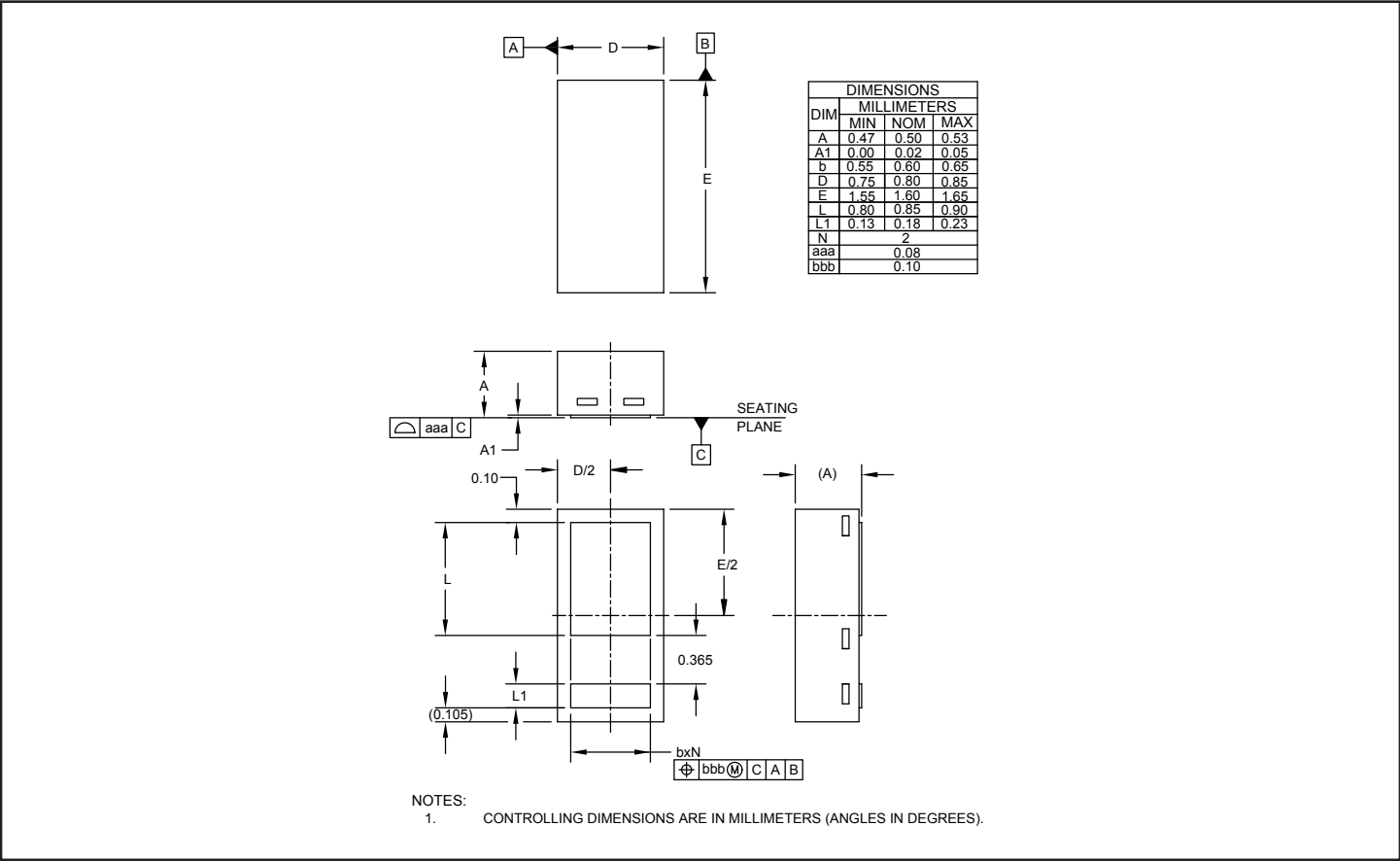
## Recommended Mounting Pattern



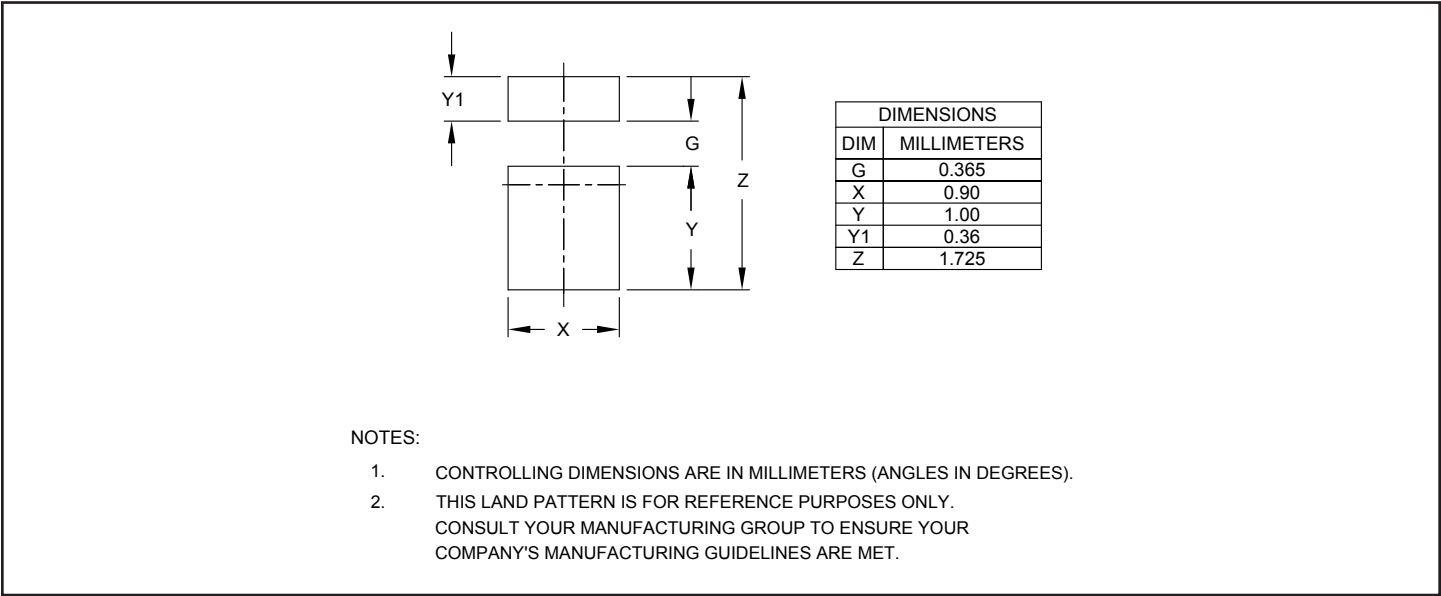
All Dimensions are in mm.  
Land Pad. Stencil opening Component

Table 1 - Recommended Assembly Guidelines	
Assembly Parameter	Recommendation
Solder Stencil Design	Laser Cut, Electro-Polished
Aperture Shape	Rectangular
Solder Stencil Thickness	0.125mm (0.005")
Solder Paste Type	Type 3 size sphere or smaller
Solder Reflow Profile	Per JEDEC J-STD-020
PCB Solder pad Design	Non-Solder Mask Defined
PCB Pad Finish	OSP or NiAu

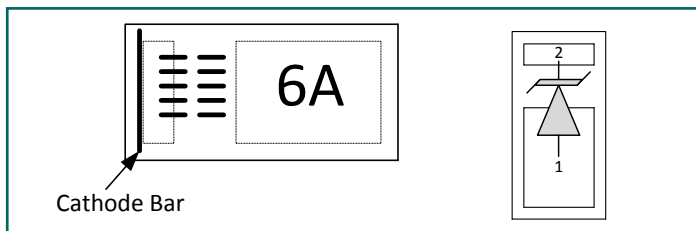
# Outline Drawing - SLP1608P2



# Land Pattern - SLP1608P2



## Marking



Notes:

- 1) Dashes represent matrix date code
- 2) See ordering information for part specific marking codes

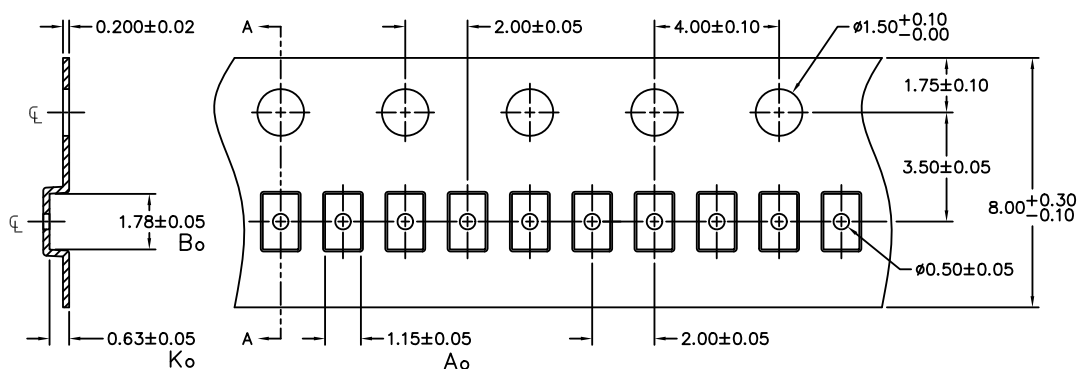
## Ordering Information

Part Number	Marking Code	Working Voltage	Qty per 7" Reel
$\mu$ Clamp0561P.TNT	6A	5V	10,000
$\mu$ Clamp1061P.TNT	6B	10V	10,000
$\mu$ Clamp1261P.TNT	6C	12V	10,000
$\mu$ Clamp1561P.TNT	6D	15V	10,000
$\mu$ Clamp2461P.TNT	6F	24V	10,000
$\mu$ Clamp3061P.TNT	6G	30V	10,000
$\mu$ Clamp3661P.TNT	6H	36V	10,000
$\mu$ Clamp4061P.TNT	6J	40V	10,000
$\mu$ Clamp6061P.TNT	6K	60V	10,000

Notes:

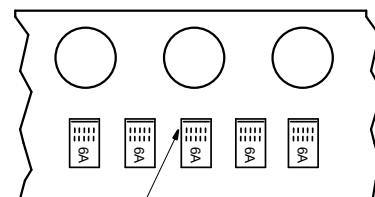
- 1) MicroClamp, uClamp and  $\mu$ Clamp are trademarks of Semtech Corporation

## Tape and Reel Specification



SECTION A-A

NOTES: 1.) ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.



Cathode Location  
(Towards Sprocket Holes)



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