RClamp0522PA
RClamp0524PA
Ultra Low Capacitance TVS Arrays

Description

RailClamp® TVS arrays are ultra low capacitance ESD protection devices 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).

The RClamp®0522PA and RClamp®0524PA have a typical capacitance of only 0.30pF between I/O pins. This allows it to be used on circuits operating in excess of 3GHz without signal attenuation. They may be used to meet the ESD immunity requirements of IEC 61000-4-2. The RClamp0522PA is designed to protect two lines, while the RClamp0524PA will protect four lines.

The RClamp0522PA is in a 6-pin SLP1610P4 package. It measures 1.6 x 1.0 with a nominal height of 0.58mm. The RClamp0524PA is in a 10-pin SLP2510P8 package. It measures 2.5 x 1.0 with a nominal height of 0.58mm. The leads are spaced at a pitch of 0.5mm and are finished with lead-free NiPdAu. They are designed for easy PCB layout by allowing the traces to run straight through the device. The combination of small size, low capacitance, and high level of ESD protection makes them a flexible solution for applications such as HDMI, DisplayPort™, MDDI, and eSATA interfaces.

Features

- ESD protection for high-speed data lines to
  IEC 61000-4-2 (ESD) ±17kV (air), ±12kV (contact)
  IEC 61000-4-5 (Lightning) 5A (8/20µs)
  IEC 61000-4-4 (EFT) 40A (5/50ns)
- Package design optimized for high speed lines
- Flow-Through design
- Protects two or four I/O lines
- Low capacitance: **0.3pF** typical (I/O to I/O)
- Low clamping voltage
- Low operating voltage: 5V
- Solid-state silicon-avalanche technology

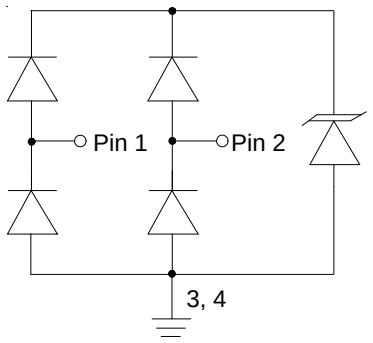
Mechanical Characteristics

- SLP1610P4 6-pin package (1.6 x 1.0 x 0.58mm)
- SLP2510P8 10-pin package (2.5 x 1.0 x 0.58mm)
- Pb-Free, Halogen Free, RoHS/WEEE Compliant
- Lead Pitch: 0.5mm
- Lead finish: NiPdAu
- Marking: Marking Code
- Packaging: Tape and Reel

Applications

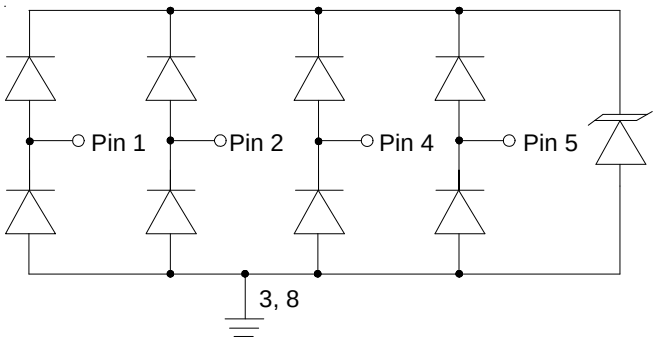
- High Definition Multi-Media Interface (HDMI)
- Digital Visual Interface (DVI)
- DisplayPort™ Interface
- MDDI Ports
- PCI Express
- eSATA Interfaces

Circuit Diagram - RClamp0522PA



2-Line Protection

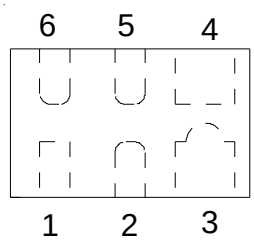
Circuit Diagram - RClamp0524PA



4-Line Protection

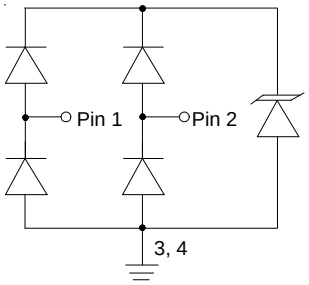
Pin Identification and Configuration

RClamp0522P



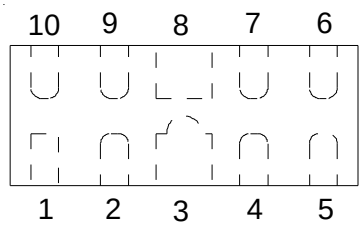
Pin	Identification
1 - 2	Input Lines
5 - 6	Output Lines (No Internal Connection)
3 - 4	Ground

SLP1610P4 Pin Configuration (Top View)



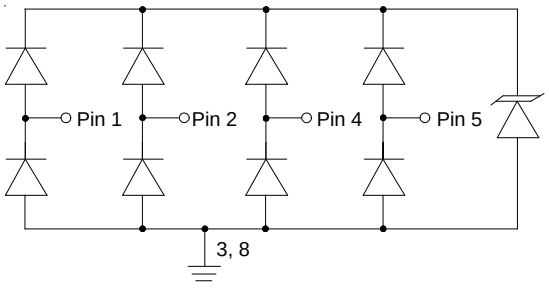
Circuit Diagram

RClamp0524P



Pin	Identification
1, 2, 4, 5	Input Lines
6, 7, 9, 10	Output Lines (No Internal Connection)
3, 8	Ground

SLP2510P8 Pin Configuration (Top View)



Circuit Diagram

Ordering Information

Part Number	Number of Lines	Qty per Reel	Reel Size
RClamp0522PATCT	2	3000	7 Inch
RClamp0524PATCT	4	3000	7 Inch

RailClamp and RClamp are marks of Semtech Corporation.

Absolute Maximum Rating

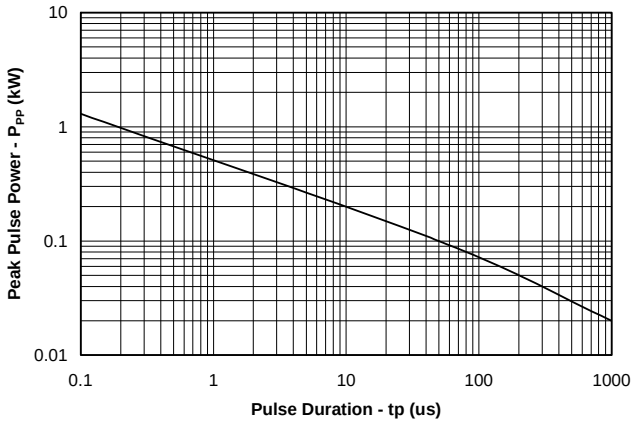
Rating	Symbol	Value	Units
Peak Pulse Power (tp = 8/20µs)	P_{pk}	150	Watts
Peak Pulse Current (tp = 8/20µs)	I_{PP}	5	A
ESD per IEC 61000-4-2 (Air) ESD per IEC 61000-4-2 (Contact)	V_{ESD}	+/- 17 +/- 12	kV
Operating Temperature	T_J	-55 to +125	°C
Storage Temperature	T_{STG}	-55 to +150	°C

Electrical Characteristics (T=25°C)

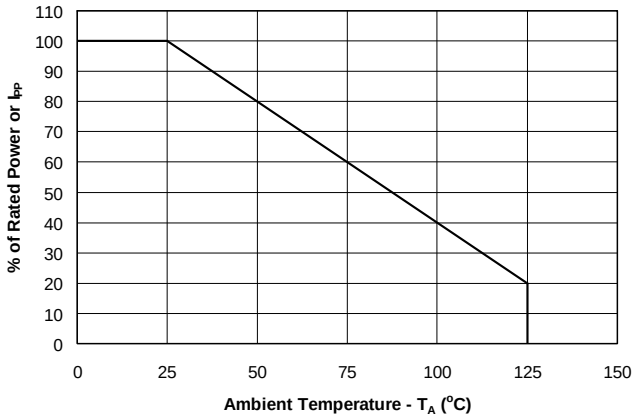
Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Reverse Stand-Off Voltage	V_{RWM}	Any I/O pin to ground			5	V
Reverse Breakdown Voltage	V_{BR}	I_t = 1mA Any I/O pin to ground	6			V
Reverse Leakage Current	I_R	V_{RWM} = 5V, T=25°C Any I/O pin to ground			1	µA
Clamping Voltage	V_C	I_{PP} = 1A, tp = 8/20µs Any I/O pin to ground			15	V
Junction Capacitance	C_j	V_R = 0V, f = 1MHz Between I/O pins		0.30	0.4	pF
Junction Capacitance	C_j	V_R = 0V, f = 1MHz Any I/O pin to ground			0.8	pF

Typical Characteristics

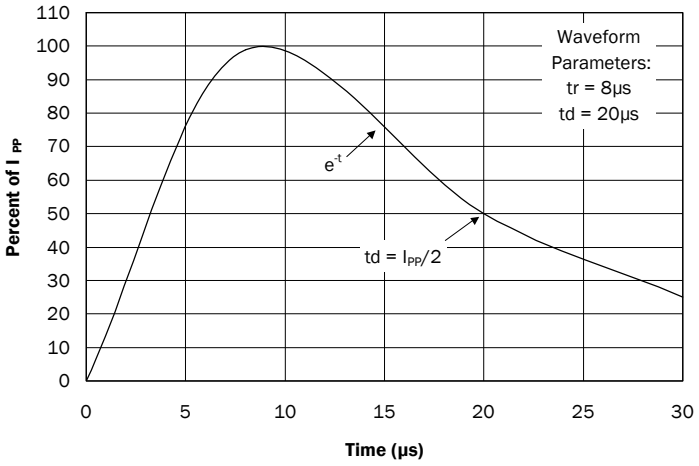
Non-Repetitive Peak Pulse Power vs. Pulse Time



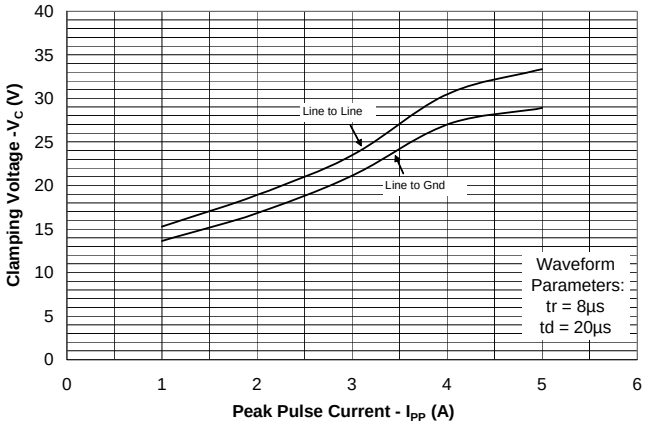
Power Derating Curve



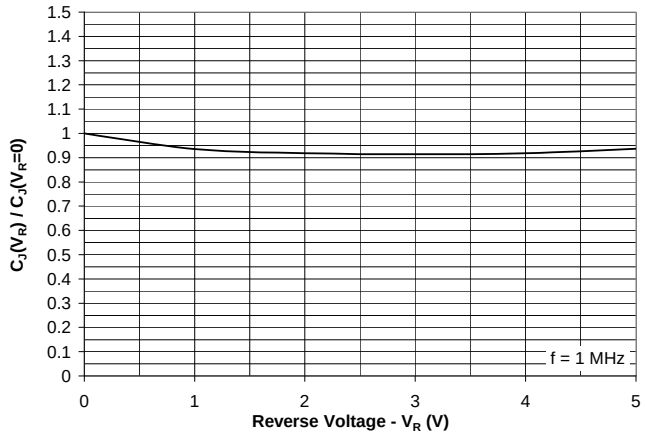
Pulse Waveform



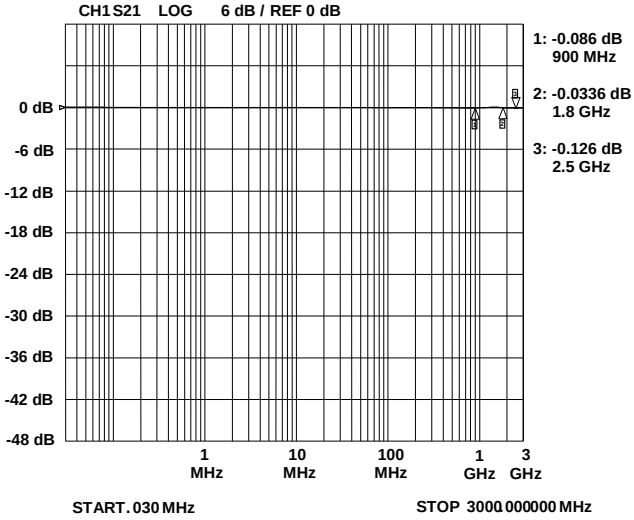
Clamping Voltage vs. Peak Pulse Current (Between any I/O and Ground)



Normalized Capacitance vs. Reverse Voltage

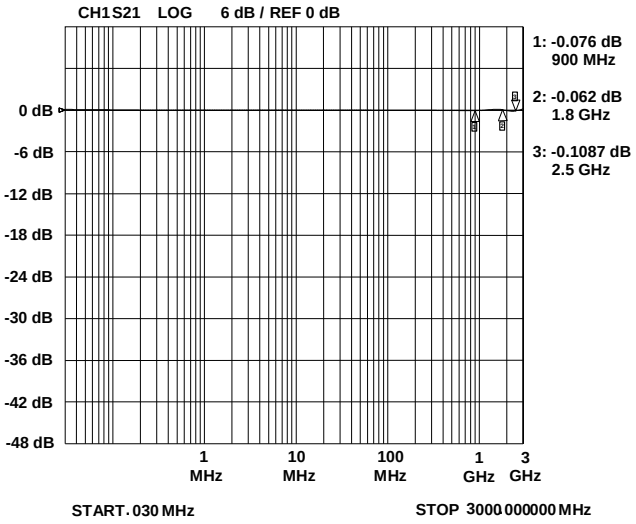


Insertion Loss S21 - I/O to GND



Typical Characteristics (Con't)

Insertion Loss S21 - I/O to I/O



Applications Information

Design Recommendations for HDMI Protection

Adding external ESD protection to HDMI ports can be challenging. First, ESD protection devices have an inherent junction capacitance. Furthermore, adding even a small amount of capacitance will cause the impedance of the differential pair to drop. Second, large packages and land pattern requirements cause discontinuities that adversely affect signal integrity. The RClamp0524PA and RClamp0522PA are specifically designed for protection of high-speed interfaces such as HDMI. They present <0.4pF capacitance between the pairs while being rated to handle >±8kV ESD contact discharges (>±15kV air discharge) as outlined in IEC 61000-4-2. Each device is in a leadless SLP package that is less than 1.1mm wide. They are designed such that the traces flow straight through the device. The narrow package and flow-through design reduces discontinuities and minimizes impact on signal integrity. This becomes even more critical as signal speeds increase.

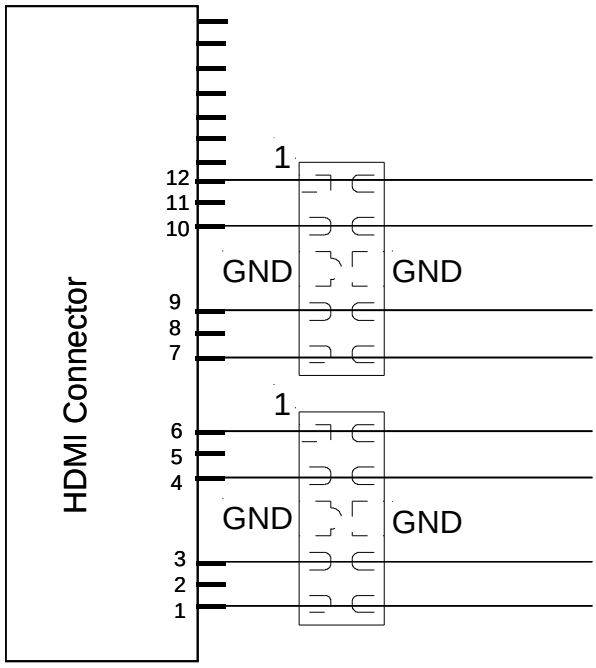


Figure 1. Flow through Layout Using RClamp0524PA

Pin Configuration

Figure 1 is an example of how to route the high speed differential traces through the RClamp0524PA. The solid line represents the PCB trace. The PCB traces are used to connect the pin pairs for each line (pin 1 to pin 10, pin 2 to pin 9, pin 4 to pin 7, pin 5 to pin 6). For example, line 1 enters at pin 1 and exits at Pin 10 and the PCB trace connects pin 1 and 10 together. This is true for lines connected at pins 2, 4, and 5 also. Ground is connected at pins 3 and 8. One large ground pad should be used in lieu of two separate pads. The same layout rules apply for the RClamp0522PA.

TDR Measurements for HDMI

The combination of low capacitance, small package, and flow-through design means it is possible to use these devices to meet the HDMI impedance requirements of 100 Ohms ±15% without any PCB board modification. Figure 3 shows a typical impedance test result for a TDR risetime of 200ps using a Semtech evaluation board with 100 Ohm traces throughout. Measurements were taken using a TDR method as outlined in the HDMI Compliance Test Specification (CTS). In each

Applications Information

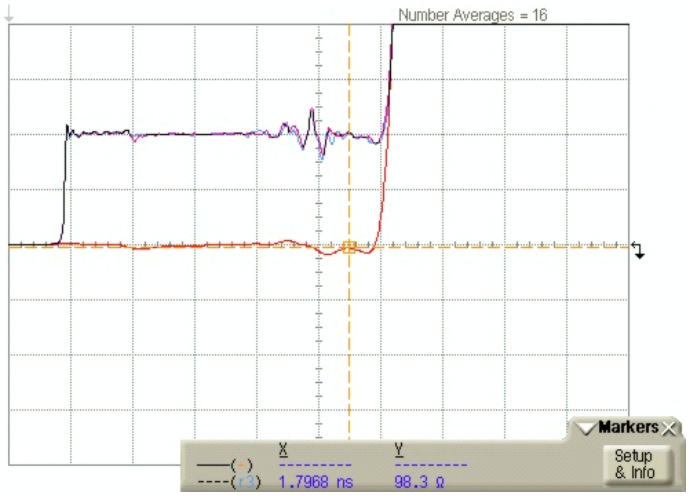
case, the device meets the HDMI CTS requirement of 100 Ohm ±15% with plenty of margin.

Figure 3 shows a typical HDMI 1.3 eye pattern at 1080p resolution. As shown there are no violations of the eye pattern with RClamp0524PA in the circuit. The RClamp0524PA may also be used to protect the remaining lines (I2C, CEC, and hot plug). Figure 4 shows the complete protection solution.

Layout Guidelines for Optimum ESD Protection

Good circuit board layout is critical not only for signal integrity, but also for effective suppression of ESD induced transients. For optimum ESD protection, the following guidelines are recommended:

- Place the device as close to the connector as possible. This practice restricts ESD coupling into adjacent traces and reduces parasitic inductance.
- The ESD transient return path to ground should be kept as short as possible. Whenever possible, use multiple micro vias connected directly from the device ground pad to the ground plane.
- Avoid running critical signals near board edges.



X-axis	1.79	**(nsec)**
Y-axis	98.3	**(Ohm)**

Figure 2 - TDR Measurement with 200ps risetime using Semtech Evaluation Board

Note: Measurements were taken on SLP HDMI EVAL Rev C Board that has 100Ω differential traces impedance throughout (No trace Compensation).

Protecting MDDI Ports with RClamp0524P and RClamp0522P

The small package size and low capacitance of the RClamp0522PA and RClamp0524PA make them ideal for high-speed lines in portable applications. One such application is the protection of MDDI ports in cellular phones. MDDI is a serial data interface operating at 480Mb/s per line pair. The lines are scalable for increased speed and display resolution. A MDDI port protection example is shown in Figure 5. The RClamp0524PA is used to protect two differential line pairs while an RClamp0522PA is used to protect the MDDI strobe lines. Note that devices are used on both the main board and LCD side of the MDDI port. Devices on the main board are needed to protect the MDDI controller in the Baseband processor and devices on the LCD board to protect MDDI controller in LCD module. A single line TVS such as the uClamp0501P is used to protect the MDDI power line. The protection devices should be placed close to the connector of each board. Traces are routed directly through each device, minimizing parasitic inductance. Connections to the ground plane should be made with multiple micro vias when possible.

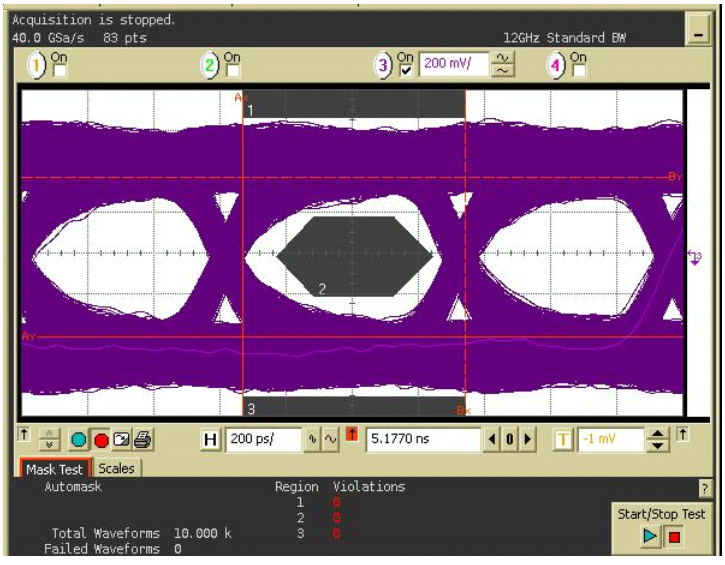


Figure 3 - Typical HDMI 1.3 Eye Pattern (1080p) with RClamp0524PA

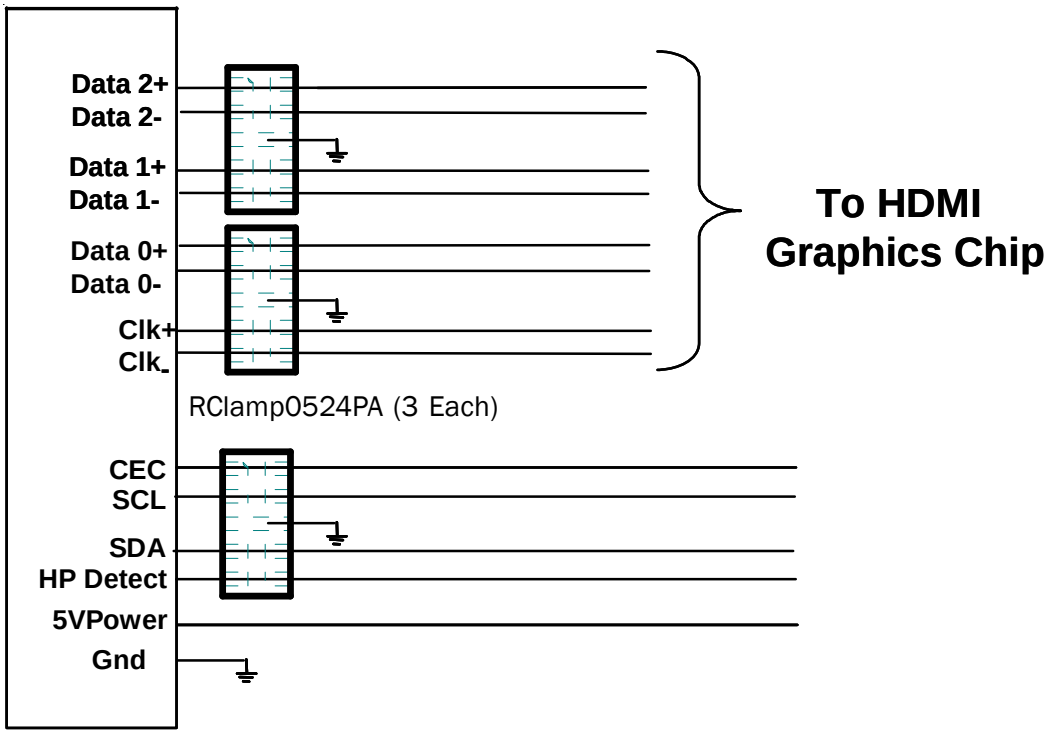


Figure 4. HDMI Protection

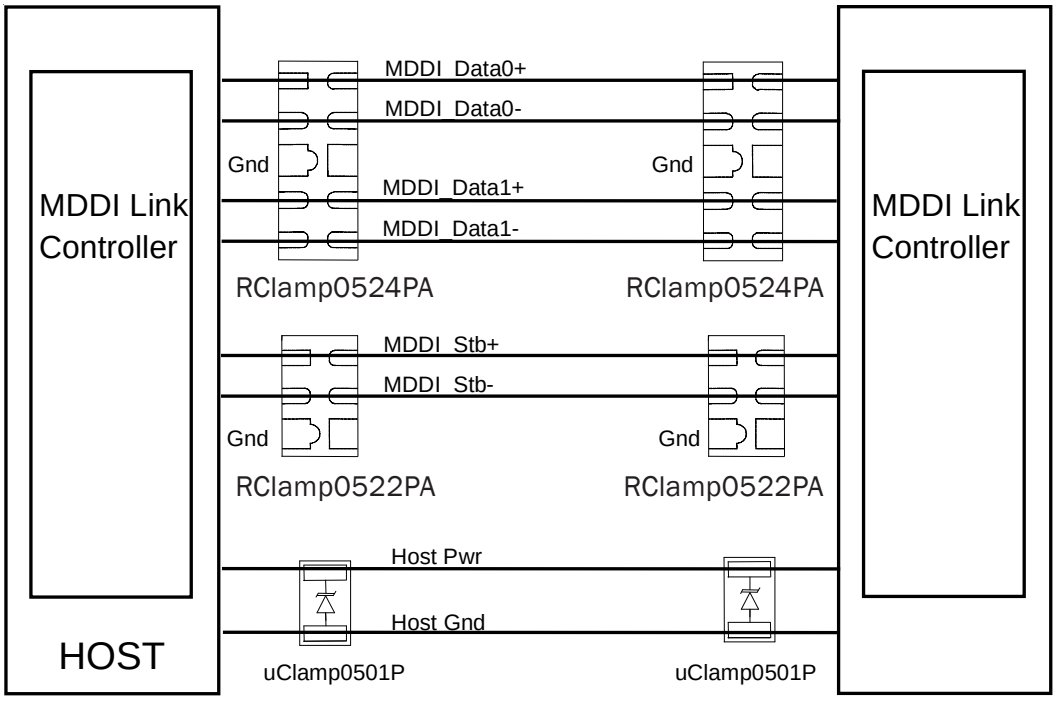
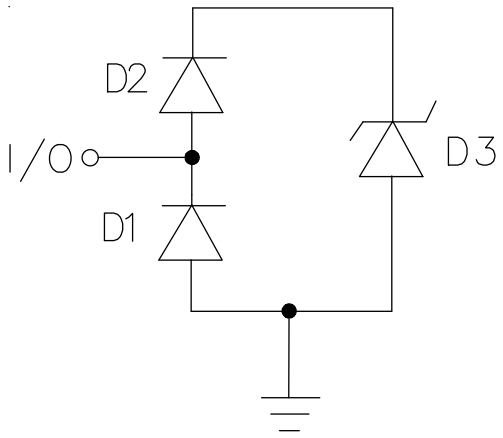


Figure 5. MDDI Port Protection

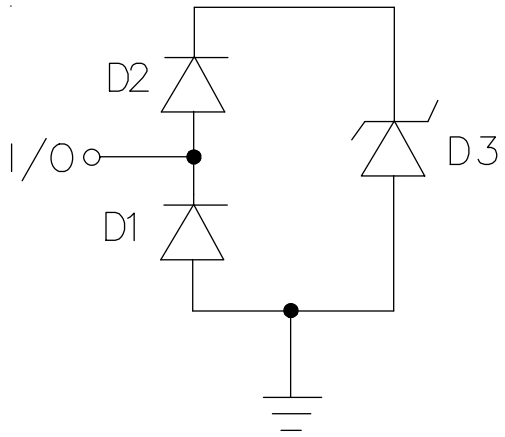
Applications Information *Spice Model*



RClamp0522PA Spice Model

RClamp0522PA Spice Parameters				
Parameter	**Unit**	**D1**	**D2**	**D3**
IS	Amp	1E-20	1E-20	2E-12
BV	Volt	100	100	8.2
VJ	Volt	0.83	0.83	0.6
RS	Ohm	1.5	0.6	0.2
IBV	Amp	1E-3	1E-3	1E-3
CJO	Farad	0.25E-12	0.25E-12	56E-12
TT	sec	2.541E-9	2.541E-9	2.541E-9
M	--	0.01	0.01	0.23
N	--	1.1	1.1	1.1
EG	eV	1.11	1.11	1.11

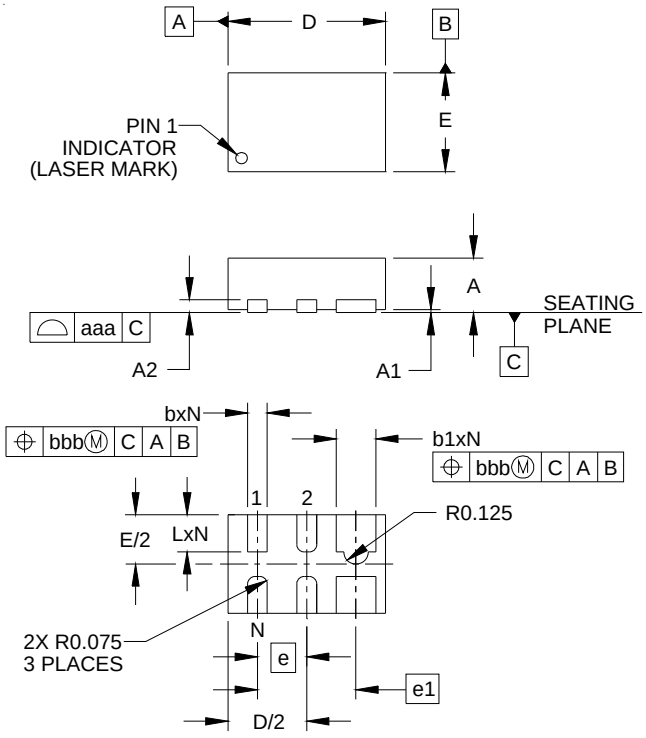
Applications Information *Spice Model*



RClamp0524PA Spice Model

RClamp0524PA Spice Parameters				
Parameter	**Unit**	**D1**	**D2**	**D3**
IS	Amp	1E-20	1E-20	2E-12
BV	Volt	100	100	8.2
VJ	Volt	0.83	0.83	0.6
RS	Ohm	1.5	0.6	0.2
IBV	Amp	1E-3	1E-3	1E-3
CJO	Farad	0.25E-12	0.25E-12	56E-12
TT	sec	2.541E-9	2.541E-9	2.541E-9
M	--	0.01	0.01	0.23
N	--	1.1	1.1	1.1
EG	eV	1.11	1.11	1.11

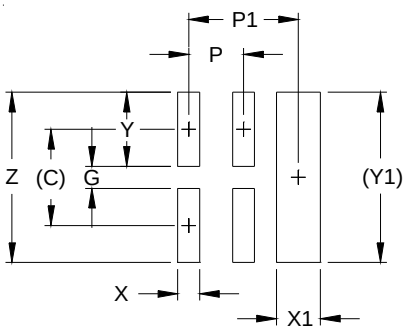
Outline Drawing - SLP1610P4



DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	.020	.023	.026	0.50	0.58	0.65
A1	0.00	.001	.002	0.00	0.03	0.05
A2		(.005)			(0.13)	
b	.006	.008	.010	0.15	0.20	0.25
b1	.014	.016	.018	0.35	0.40	0.45
D	.059	.063	.067	1.50	1.60	1.70
E	.035	.039	.043	0.90	1.00	1.10
e	.020 BSC			0.50 BSC		
e1	.039 BSC			1.00 BSC		
L	.012	.015	.017	0.30	0.38	0.43
N	4			4		
aaa	.003			0.08		
bbb	.004			0.10		

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

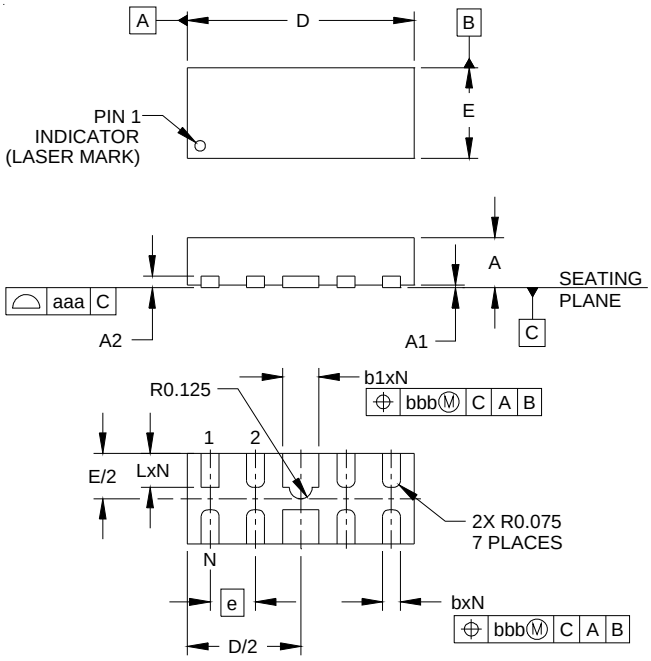
Land Pattern - SLP1610P4



DIM	INCHES	MILLIMETERS
C	(.034)	(0.87)
G	.007	0.19
P	.020	0.50
P1	.039	1.00
X	.008	0.20
X1	.016	0.40
Y	.027	0.68
Y1	(.061)	(1.55)
Z	.061	1.55

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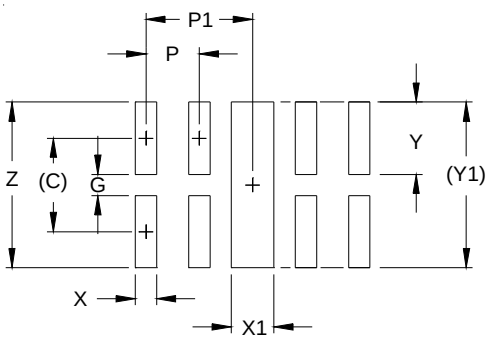
Outline Drawing - SLP2510P8



DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	.020	.023	.026	0.50	0.58	0.65
A1	0.00	.001	.002	0.00	0.03	0.05
A2		(.005)			(0.13)	
b	.006	.008	.010	0.15	0.20	0.25
b1	.014	.016	.018	0.35	0.40	0.45
D	.094	.098	.102	2.40	2.50	2.60
E	.035	.039	.043	0.90	1.00	1.10
e		.020 BSC			0.50 BSC	
L	.012	.015	.017	0.30	0.38	0.425
N		8			8	
aaa		.003			0.08	
bbb		.004			0.10	

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

Land Pattern - SLP2510P8

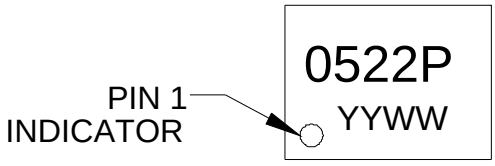


DIM	INCHES	MILLIMETERS
C	(.034)	(0.875)
G	.008	0.20
P	.020	0.50
P1	.039	1.00
X	.008	0.20
X1	.016	0.40
Y	.027	0.675
Y1	(.061)	(1.55)
Z	.061	1.55

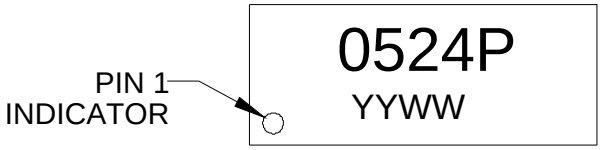
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Marking Codes

RClamp0522PA

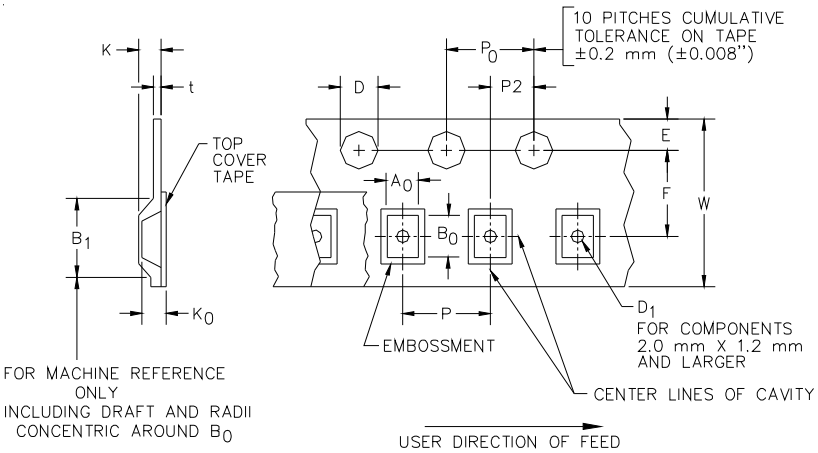


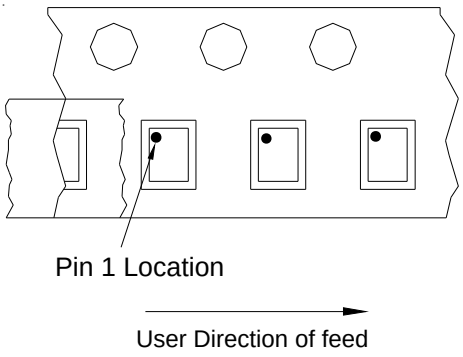
RClamp0524PA



YYWW = Date Code

Tape and Reel Specification





Device Orientation in Tape

Part Number	A0	B0	K0
RClamp0522PA	1.30 +/-0.05 mm	1.75 +/-0.05 mm	0.70 +/-0.05 mm
RClamp0524PA	1.23 +/-0.05 mm	2.70 +/-0.05 mm	0.70 +/-0.05 mm

Tape Width	B, (Max)	D	D1	E	F	K (MAX)	P	P0	P2	T(MAX)	W
8 mm	4.2 mm	1.5 + 0.1 mm - 0.0 mm)	0.5 mm ±0.05	1.750±.10 mm	3.5±0.05 mm	2.4 mm	4.0±0.1 mm	4.0±0.1 mm	2.0±0.05 mm	0.4 mm	8.0 mm + 0.3 mm - 0.1 mm

Contact Information

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SEMTECH:

RCLAMP0502N.TCT ECLAMP2378P.TCT ECLAMP2384K.TCT GS2971AIBE3 GS9068-CKA
RCLAMP3346P.TNT RCLAMP3371ZCTFT SD15C.TCT GS9015BCPJ RCLAMP3304N.TCT SC189ASKTRT
UCLAMP0871P.TNT UCLAMP2801T.TCT RCLAMP0504FATCT ECLAMP2454P.TCT LCDA12.TBT
RCLAMP01831ZA.F RCLAMP0502B.TCT RCLAMP3346PQTNT SLVU2.8-4.TBT SX1262IMLTRT
SMDA24C-5.TBT SR2.8.TCT RCLAMP0504F.TCT RCLAMP0594P.TAT RCLAMP2504N.TCT
SMDA24C-7.TBT UCLAMP3311P.TCT RCLAMP3354S.TCT TCLAMP3302N.TCT