2 Channel ESD Protection Array

Features

- 2 channels of ESD protection
- ±8 kV contact, ±15 kV air ESD protection per per channel (IEC 61000-4-2 standard)
- ±15 kV of ESD protection per channel (HBM)
- Low loading capacitance—3 pF typical
- Low leakage current—ideal for battery-powered devices
- Miniature 4-pin SOT-143 package

Applications

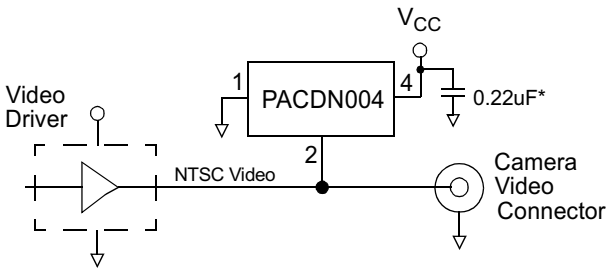
- Consumer electronic products
- Cellular phones
- PDAs
- Notebook computers
- Desktop PCs
- Digital cameras and camcorders
- VGA (video) port protection for desktop and portable PCs

Product Description

The PACDN004 is a diode array designed to provide two channels of ESD protection for electronic components or sub-systems. Each channel consists of a pair of diodes which steers the ESD current pulse either to the positive (V_P) or negative (V_N) supply. The PACDN004 will protect against ESD pulses up to 15 kV Human Body Model, and 8kV contact discharge per International Standard IEC 61000-4-2.

This device has identical characteristics as the PACDN006 (6-channel array). They can be used together in order to provide a larger number of protected inputs if required. This device is particularly well-suited for a wide range of portable electronics (e.g. cellular phones, PDAs, notebook computers) because of its small package footprint, high ESD protection level and low loading capacitance. It is also suitable for protecting video output lines and I/O ports in computers

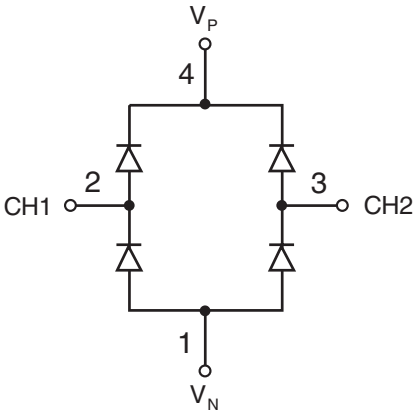
Typical Application Circuit



Digital Camera Video Port ESD Protection

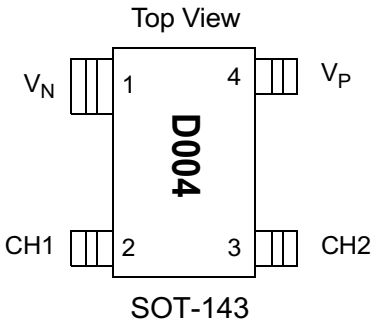
* Decoupling capacitor must be placed as close as possible to Pin4.

Simplified Electrical Schematic



© 2002 California Micro Devices Corp. All rights reserved.

PACKAGE / PINOUT DIAGRAM



Note: Drawing not to scale.

PIN DESCRIPTIONS

PIN	NAME	TYPE	DESCRIPTION
1	V_N	Gnd	Negative voltage supply rail or ground reference rail
2	CH1	I/O	ESD Channel 1
3	CH2	I/O	ESD Channel 2
4	V_P	Supply	Positive voltage supply rail

Ordering Information

PART NUMBERING INFORMATION

Pins	Package	Ordering Part Number[1]	Part Marking
4	SOT-143	PACDN004Y	D004

Note 1: Parts are shipped in Tape & Reel form unless otherwise specified.

© 2002 California Micro Devices Corp. All rights reserved.

Specifications

ABSOLUTE MAXIMUM RATINGS		
PARAMETER	**RATING**	**UNITS**
Supply Voltage (V_P - V_N)	6.0	V
Diode Forward DC Current (Note 1)	20	mA
Operating Temperature Range	-40 to +85	°C
Storage Temperature Range	-65 to +150	°C
DC Voltage at any channel input	(V_N - 0.5) to (V_P + 0.5)	V
Package Power Rating	225	mW

Note 1: Only one diode conducting at a time.

STANDARD OPERATING CONDITIONS		
PARAMETER	**RATING**	**UNITS**
Operating Temperature Range	-40 to +85	°C
Operating Supply Voltage (V_P - V_N)	0 to 5.5	V

ELECTRICAL OPERATING CHARACTERISTICS[1]						
SYMBOL	**PARAMETER**	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**UNITS**
I_P	Supply Current	(V_P-V_N)=5.5V			10	µA
V_F	Diode Forward Voltage	I_F = 20mA	0.65		0.95	V
I_{LEAK}	Channel Leakage Current			±0.1	±1.0	µA
C_{IN}	Channel Input Capacitance	@ 1 MHz, V_P=5V, V_N=0V, V_{IN}=2.5V; Note 2 applies		3	5	pF
V_{ESD}	ESD Protection Peak Discharge Voltage at any channel input, in system Human Body Model, MIL-STD-883, Method 3015 Contact discharge per IEC 61000-4-2 standard	 Note 3 Notes 2,4 Notes 2,5	 ±15 ±8			 kV kV
V_{CL}	Channel Clamp Voltage Positive Transients Negative Transients	@15kV ESD HBM; Notes 2 & 4			 V_P + 13.0 V_N - 13.0	 V V

Note 1: All parameters specified at T_A=25°C unless otherwise noted.

Note 2: These parameters guaranteed by design and characterization.

Note 3: From I/O pins to V_P or V_N only. V_P bypassed to V_N with a 0.22µF ceramic capacitor (see Application Information for more details).

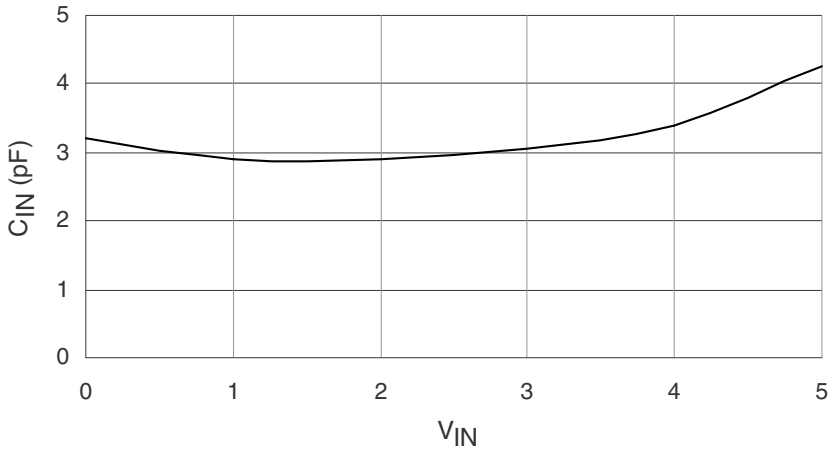
Note 4: Human Body Model per MIL-STD-883, Method 3015, $C_{Discharge}$ = 100pF, $R_{Discharge}$ = 1.5KΩ, V_P = 5.0V, V_N grounded.

Note 5: Standard IEC 61000-4-2 with $C_{Discharge}$ = 150pF, $R_{Discharge}$ = 330Ω, V_P = 5.0V, V_N grounded.

© 2002 California Micro Devices Corp. All rights reserved.

Performance Information

Input Capacitance vs. Input Voltage



Typical Variation of C_{IN} vs. V_{IN}

(V_P = 5V, V_N = 0V, 0.1 µF chip capacitor between V_P and V_N)

© 2002 California Micro Devices Corp. All rights reserved.

Application Information

Design Considerations

In order to realize the maximum protection against ESD pulses, care must be taken in the PCB layout to minimize parasitic series inductances on the Supply/ Ground rails as well as the signal trace segment between the signal input (typically a connector) and the ESD protection device. Refer to Figure 1, which illustrates an example of a positive ESD pulse striking an input channel. The parasitic series inductance back to the power supply is represented by L_1 and L_2. The voltage V_{CL} on the line being protected is:

$$V_{CL} = \text{Fwd voltage drop of } D_1 + V_{SUPPLY} + L_1 \times d(I_{ESD}) / dt + L_2 \times d(I_{ESD}) / dt$$

where I_{ESD} is the ESD current pulse, and V_{SUPPLY} is the positive supply voltage.

An ESD current pulse can rise from zero to its peak value in a very short time. As an example, a level 4 contact discharge per the IEC61000-4-2 standard results in a current pulse that rises from zero to 30 Amps in 1ns. Here $d(I_{ESD})/dt$ can be approximated by $\Delta I_{ESD}/\Delta t$, or $30/(1x10^{-9})$. So just 910nH of series inductance (L_1 and L_2 combined) will lead to a 300V increment in V_{CL}!

Similarly for negative ESD pulses, parasitic series inductance from the V_N pin to the ground rail will lead to drastically increased negative voltage on the line being protected.

Another consideration is the output impedance of the power supply for fast transient currents. Most power supplies exhibit a much higher output impedance to fast transient current spikes. In the V_{CL} equation above, the V_{SUPPLY} term, in reality, is given by (V_{DC} + I_{ESD} x R_{OUT}), where V_{DC} and R_{OUT} are the nominal supply DC output voltage and effective output impedance of the power supply respectively. As an example, a R_{OUT} of 1 ohm would result in a 10V increment in V_{CL} for a peak I_{ESD} of 10A.

If the inductances and resistance described above are close to zero, the rail-clamp ESD protection diodes will do a good job of protection. However, since this is not possible in practical situations, a bypass capacitor must be used to absorb the very high frequency ESD energy. So for any brand of rail-clamp ESD protection diodes, a bypass capacitor should be connected between the V_P pin of the diodes and the ground plane (V_N pin of the diodes) as shown in the Application Circuit diagram below. A value of 0.22µF is adequate for IEC-61000-4-2 level 4 contact discharge protection (±8kV). Ceramic chip capacitors mounted with short printed circuit board traces are good choices for this application. Electrolytic capacitors should be avoided as they have poor high frequency characteristics. For extra protection, connect a zener diode in parallel with the bypass capacitor to mitigate the effects of the parasitic series inductance inherent in the capacitor. The breakdown voltage of the zener diode should be slightly higher than the maximum supply voltage.

As a general rule, the ESD Protection Array should be located as close as possible to the point of entry of expected electrostatic discharges. The power supply bypass capacitor mentioned above should be as close to the V_P pin of the Protection Array as possible, with minimum PCB trace lengths to the power supply, ground planes and between the signal input and the ESD device to minimize stray series inductance.

Additional Information

See also California Micro Devices Application Notes AP209, “Design Considerations for ESD Protection” and AP219, "ESD Protection for USB 2.0 Systems"

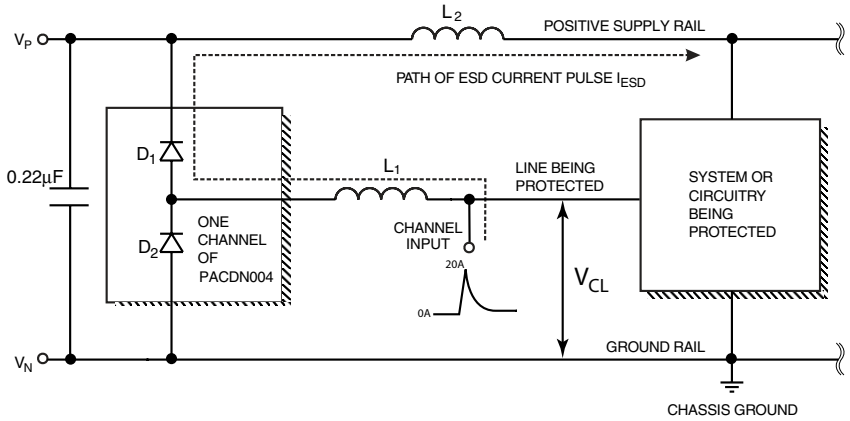


Figure 1. Application of Positive ESD Pulse between Input Channel and Ground

© 2002 California Micro Devices Corp. All rights reserved.

Mechanical Details

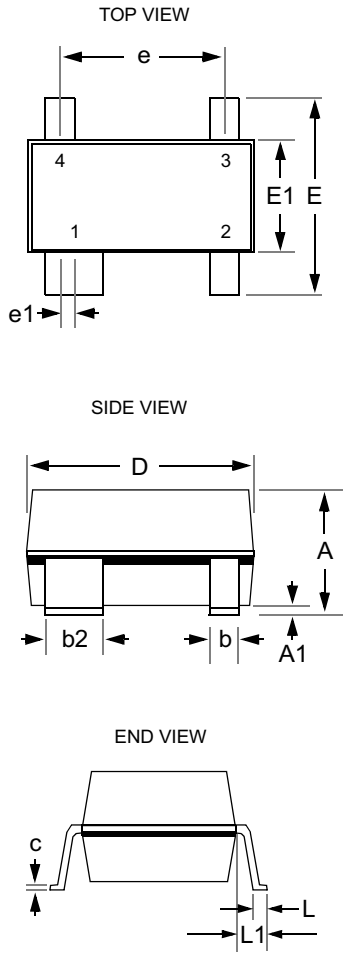
SOT-143 Mechanical Specifications

PACDN004 devices are packaged in 4-pin SOT-143 packages. Dimensions are presented below.

For complete information on the SOT-143 package, see the California Micro Devices SOT-143 Package Information document.

PACKAGE DIMENSIONS				
Package	SOT-143			
Pins	4			
Dimensions	**Millimeters**		**Inches**	
	Min	**Max**	**Min**	**Max**
A	0.80	1.22	0.031	0.048
A1	0.05	0.15	0.002	0.006
b	0.30	0.50	0.012	0.019
b2	0.76	0.89	0.030	0.035
c	0.08	0.20	0.003	0.008
D	2.80	3.04	0.110	0.119
E	2.10	2.64	0.082	0.103
E1	1.20	1.40	0.047	0.055
e	1.92 BSC		0.075 BSC	
e1	0.20 BSC		0.008 BSC	
L	0.4	0.6	0.016	0.024
L1	0.54 REF		0.021 REF	
# per tape and reel	3000 pieces			
Controlling dimension: millimeters				

Mechanical Package Diagrams



Package Dimensions for SOT-143.

© 2002 California Micro Devices Corp. All rights reserved.