



## 6 CHANNEL ESD PROTECTION ARRAY WITH ZENER SUPPLY CLAMP

### Features

- Six channels of ESD protection
- Integral Zener diode clamp to suppress supply rail transient
- 15KV ESD protection (HBM)
- 8KV contact, 15KV air ESD protection per IEC 61000-4-2
- Low loading capacitance, 3pF typ
- Miniature 8-pin MSOP or SOIC package

### Applications

- I/O port protection for cellular phones, notebook computers, PDAs, etc.
- ESD protection for VGA (Video) port in PC's or Notebook computers.
- ESD protection for sensitive electronic equipment.

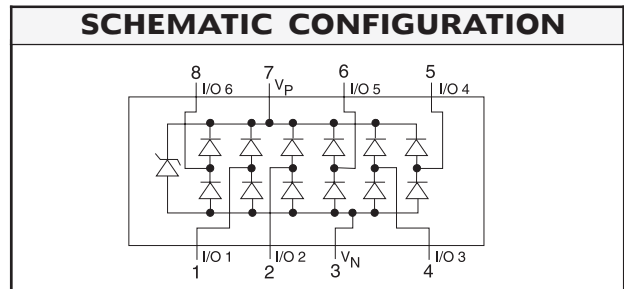
### Product Description

The PAC™ DN016 is a diode array designed to provide 6 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. In addition, there is an integral Zener diode between  $V_P$  and  $V_N$  to suppress any voltage disturbance due to these ESD current pulses. The PAC DN016 will protect against ESD pulses up to 15KV Human Body Model, and 8KV contact discharge per International Standard IEC 61000-4-2.

This device is particularly well-suited for 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 and peripheral equipment.

ABSOLUTE MAXIMUM RATINGS	
Diode Forward DC Current (Note 1)	20mA
Storage Temperature	-65°C to 150°C
Operating Temperature Range	-20°C to 85°C
DC Voltage at any Channel Input	$V_N - 0.5V$ to $V_P + 0.5V$

Note 1: Only one diode conducting at a time.



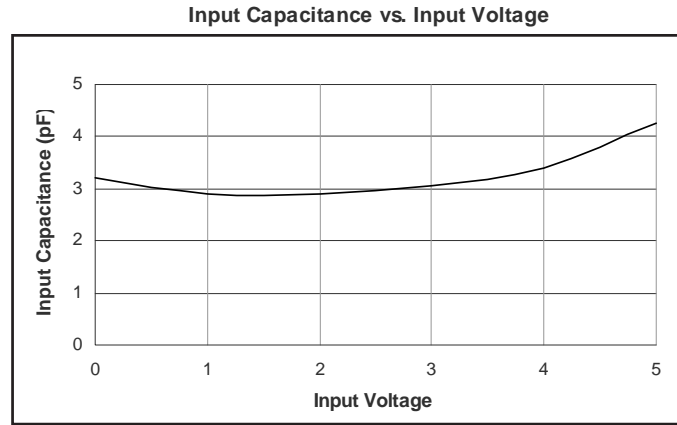
STANDARD SPECIFICATIONS			
Parameter	Min.	Typ.	Max.
Operating Supply Voltage ( $V_P - V_N$ )			5.5V
Supply Current @ $V_P - V_N = 5.5V$			20µA
Diode Forward Voltage, $I_F = 20mA, T = 25°C$	0.65V		0.95V
Zener clamp reverse breakdown voltage @ 1mA, $T = 25°C$		6.6V	
ESD Protection			
Peak Discharge Voltage at any Channel Input, in-system (Note 2)			
Human Body Model, Method 3015 (Note 3, 4)	±15KV		
Contact Discharge per IEC 61000-4-2 (Note 5)	±8KV		
Channel Clamp Voltage @ 15KV ESD HBM, $T = 25°C$ (Notes 3, 4)			
Positive transients			$V_P + 13.0V$
Negative transients			$V_N - 13.0V$
Channel Leakage Current, $T = 25°C$		±0.1µA	±1.0 µA
Channel Input Capacitance (Measured @ 1 MHz) $V_P = 5V, V_N = 0V, V_{INPUT} = 2.5V$ (Note 4)		3pF	6pF
Package Power Rating			
SOIC Package			350mW
MSOP Package			200mW

Note 2: From I/O pins to  $V_P$  or  $V_N$  only. Bypass opacitor between  $V_P$  and  $V_N$  is not required. However, a 0.2 µF ceramic chip capacitor bypassing  $V_P$  to  $V_N$  is recommended if the lowest possible channel clamp voltage is desired.

Note 3: Human Body Model per MIL-STD-883, Method 3015,  $C_{Discharge} = 100pF, R_{Discharge} = 1.5KΩ, V_P = 5.0V, V_N = GND.$

Note 4: This parameter is guaranteed by design and characterization.

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



Typical variation of  $C_{IN}$  with  $V_{IN}$  ( $V_P=5V$ ,  $V_N=0V$ )  
 ( $V_P = 5V$ ,  $V_N = 0V$ ,  $0.1\mu F$  chip capacitor between  $V_P$  &  $V_N$ )

STANDARD PART ORDERING INFORMATION			
Package		Ordering Part Number	
Pins	Style	Part Marking	
8	SOIC	PACDN016S	
8	MSOP	PACDN016M	

When placing an order please specify desired shipping: Tubes or Tape & Reel.

**Application Information**

See also California Micro Devices Application note AP209, "Design Considerations for ESD protection."

In order to realize the maximum protection against ESD pulses, care must be taken in the PCB layout to minimize parasitic series inductances to the Supply and Ground rails. Refer to Figure 1, which illustrates the case of a positive ESD pulse applied between an input channel and Chassis Ground. The parasitic series inductance back to the power supply is represented by  $L_1$ . The voltage  $V_Z$  on the line being protected is:

$$V_Z = \text{Forward voltage drop of } D_1 + L_1 \times d(I_{esd})/dt + V_{Supply}$$

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

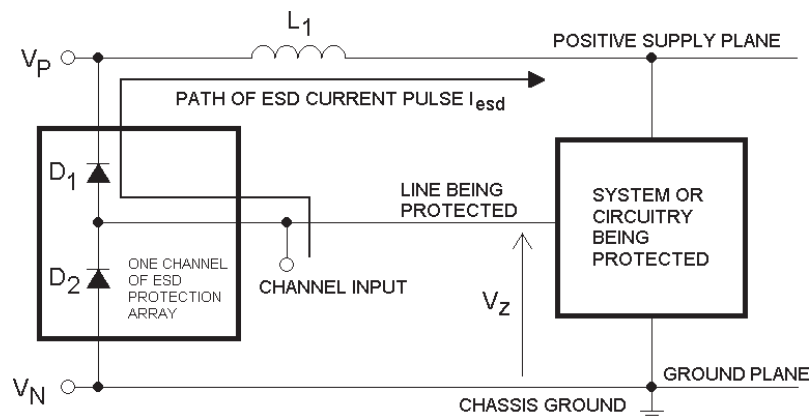


Figure 1

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 IEC 61000-4-2 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  $30/(1 \times 10^{-9})$ . So just 10nH of series inductance ( $L_1$ ) will lead to a 300V increment in  $V_Z$ !



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  $V_Z$  equation above, the  $V_{Supply}$  term, in reality, is given by  $(V_{DC} + I_{esd} \times R_{out})$ , 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  $V_Z$  for a peak  $I_{esd}$  of 10A.

To mitigate these effects, a Zener diode has been integrated into this Protection Array between  $V_p$  and  $V_N$ . This Zener diode clamps the maximum voltage of  $V_p$  relative to  $V_N$  at the breakdown voltage of the Zener diode. Although not strictly necessary, it is recommended that  $V_p$  be bypassed to the ground plane with a high frequency bypass capacitor. This will lower the channel clamp voltage, and is especially effective when  $V_p$  is much lower than the Zener breakdown voltage. The value of this bypass capacitor should be chosen such that it will absorb the charge transferred by the ESD pulse with minimal change in  $V_p$ . Typically a value in the 0.1  $\mu F$  to 0.2  $\mu F$  range is adequate for IEC-61000-4-2 level 4 contact discharge protection (8KV). For higher ESD voltages, the bypass capacitor should be increased accordingly. 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.

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 and ground planes to minimize stray series inductance.

Figure 5