

DESIGN SHOWCASE

Op-Amp Inputs Provide Ultra Low-leakage Clamps

The input-protection diodes of a precision op amp can serve as clamp diodes for two independent analog-signal lines (Figure 1). For signal excursions between the clamping levels, the device shown offers extremely low-leakage currents of 50 to 100fA at 25°C.

Clamp voltages V_1 and $-V_2$ connect to the supply terminals of this low-voltage CMOS amplifier. You can set the clamp voltages anywhere between zero and the absolute-maximum supply voltage (12V), provided V_1 is more positive than $-V_2$. Connect pin 8 to pin 4, and leave pins 1, 5, and 6 unconnected. The amplifier draws less than 50 μ A typical for these conditions, with 10V between V_1 and $-V_2$. If pin 3 remains

positive with respect to pin 2, the typical supply current is less than 1 μ A.

Maxim specifies the room-temperature leakage at 10pA, but actual values measure a few tens of femtoamperes. The package boosts this value to between 50 and 100fA, and the leakage approximately doubles for each eight-degree increase. Extrapolating back from the maximum specs based on testing (20pA at 70°C, 50pA at 85°C, and 1000pA at 125°C) yields less than 0.5pA at 25°C.

Low leakage is achieved by small diode geometries, which also limit the permissible steady-state clamp currents (to ± 10 mA). Table 1 lists the net forward voltage vs. current at 20°C for the positive clamp diodes (associated with V_1) and the negative clamp diodes (associated with $-V_2$). Input capacitance is 2 to 3pF, depending on the package.

The MAX406 costs \$2.54 (1000 pc). Other alternatives from Siliconix are more expensive. Their best low-leakage clamp diode (PAD1) specifies 1pA at room temperature and costs \$1.35 (1000 pc); four of these (the MAX406 equivalent) cost \$5.40 (1000 pc). Their dual low-leakage diode (DPAD1) specifies 1pA max at room temperature (no spec at higher temp), and costs \$6.37 (1000 pc); two DPAD1s (the MAX406 equivalent) cost \$12.74 (1000 pc).

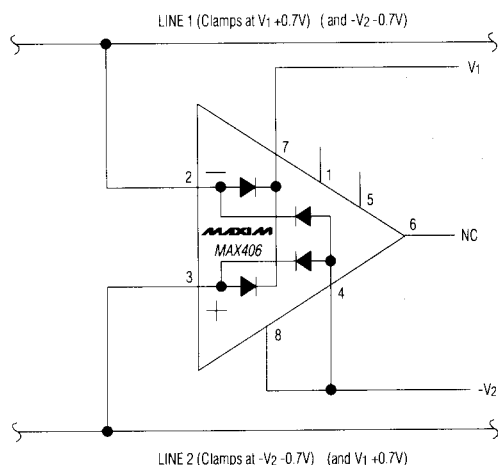


Figure 1. Low-leakage protection diodes in this precision CMOS op amp serve as bipolar clamps for two analog-signal lines.

(Circle 2)

TABLE 1. DIODE FORWARD VOLTAGE vs. CURRENT

Positive (V_1)		Negative ($-V_2$)	
Diode Current (mA)	Diode Voltage (V)	Diode Current (mA)	Diode Voltage (V)
0.01	0.635	-0.01	-0.608
0.10	0.714	-0.10	-0.670
1.00	0.822	-1.00	-0.751
2.00	0.861	-2.00	-0.787
5.00	0.921	-5.00	-0.858
10.00	0.980	-10.00	-0.931