High-impedance buffer amplifier's input includes ESD protection

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Certain measurement applications, such as for pH (acidity) and bio-potentials, require a high-impedance buffer amplifier. Although several semiconductor manufacturers offer amplifier ICs featuring low bias and offset-input currents, attaching a sensor cable to an amplifier circuit can inflict damage from ESD (electrostatic discharge). **Figure 1** shows one unsatisfactory approach to ESD protection. Resistor R_1 limits an ESD event's discharge current, and diodes D_{1A} and D_{1B} clamp amplifier IC_1's input to its power-supply rails. Unfortunately, when shunting a pH sensor's 400-MΩ input impedance, even low-leakage diodes, such as Fairchild Semiconductor's (www.fairchildsemi.com) MMBD-1503A, introduce significant offset voltages.

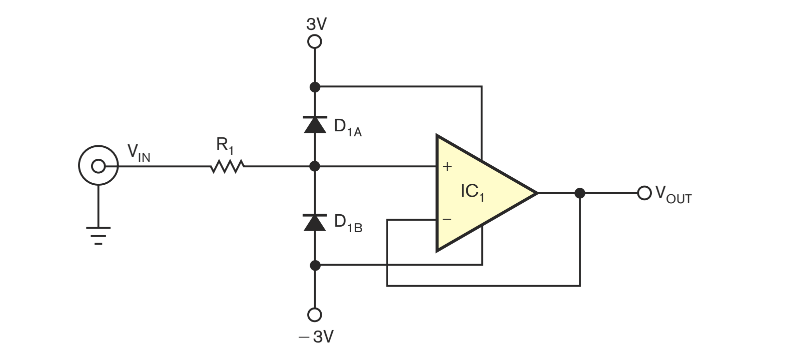

Figure 1 In a conventional ESD-suppression circuit, diodes clamp an amplifier's input voltage to its power-supply rails but introduce unwanted leakage currents.

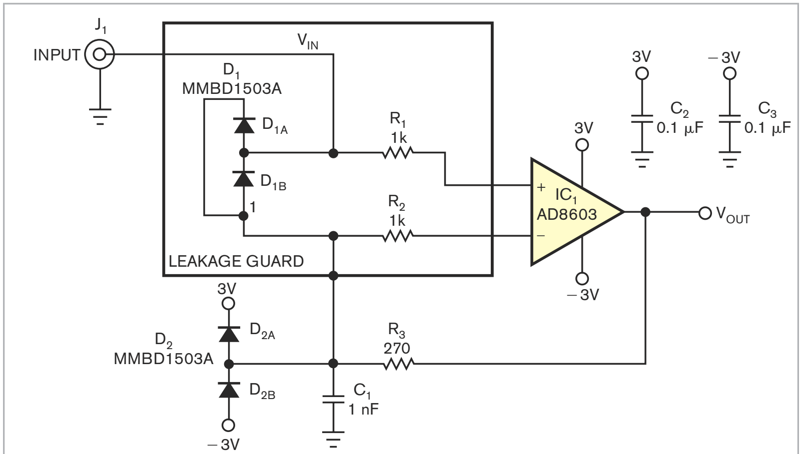

Figure 2 In this alternative design, voltage across both halves of D_1 normally approaches 0V and introduces no leakage currents. During an ESD event, both D_1 and D_2 conduct to protect IC_1's inputs.

The circuit in **Figure 2** offers an alternative approach. An Analog Devices (www.analog.com) low-input-bias, low-offset-current AD8603 amplifier, IC_1, serves as a unity-gain input buffer. For any normal input, the circuit's output voltage, V_{OUT}, equals its input voltage, V_{IN}. Thus, the voltage across ESD-protection diode D_{1A} or D_{1B} approaches 0V, and neither diode's leakage current affects the sensor's output signal. Depending on the polarity of an ESD event you apply to the circuit's input connector, its high-voltage spike discharges through diode D_{1A} or D_{1B} into the positive or the negative

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power-supply rail. Capacitor C_1 acts as an intermediate "charge reservoir" that slows the ESD spike's rate of rise and protects IC_1's output stage from latching until diode D_{2A} or D_{2B} begins diversion of the ESD transient into the positive or the negative supply rail. In effect, C_1 compensates for D_1's parasitic capacitance. Resistor R_3 allows IC_1 to drive the capacitive load that C_1 presents without going into oscillation.

During an ESD event, both D_1 and D_2 can conduct, but the voltage at V_{IN} exceeds the power-supply-rail voltage by only two forward-biased diode voltage drops. Resistors R_1 and R_2 limit the amplifier input's currents below the manufacturer's recommended 5-mA maximum rating.

When packaging the circuit, pay special attention to the pc board's layout. Imperfections in the board's dielectric properties can provide parasitic-leakage-current paths. Adding copper traces on both sides of the board to form guard rings around the circuit's high-impedance nodes diverts leakage currents (**Figure 3**).EDN

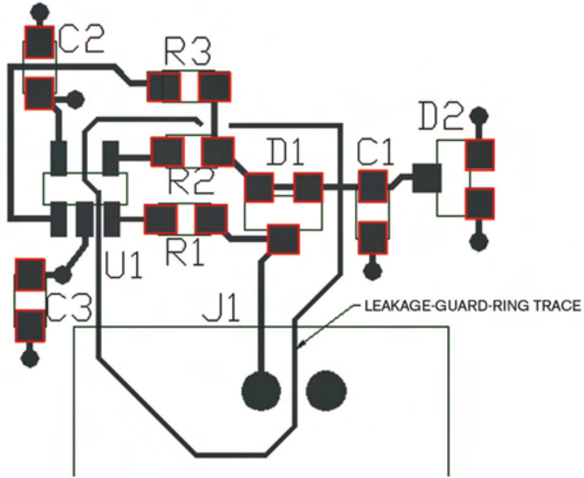

Figure 3 For best performance, place copper traces around the amplifier's high-impedance points to intercept leakage currents.