

PROTECTION PRODUCTS

ESD Protection

Reliable system design requires some form of ESD protection. Although several types of transient protection devices are available, care must be taken when deciding which device to use. An ill-chosen device will not only be ineffective, but can interfere with the normal operation of the circuit. For suppression of transients in portable systems, the protection device must provide the following characteristics:

- Extremely fast response time
- Low clamping and operating voltages
- Capacity to handle high peak ESD currents
- Ability to remain undamaged by repetitive ESD strikes
- Minimal size
- Minimal reverse leakage current

TVS diodes are an ideal choice for board level ESD protection. They meet all of the above criteria and have proven effective in the suppression of ESD events. TVS diodes can protect even the most sensitive semiconductor devices. For data and supply voltages down to 5 volts, a device employing a p-n junction construction is used. For circuits operating below 5 volts, high leakage currents and junction capacitance render conventional p-n junction technology impractical. Innovations in TVS diode design have provided devices capable of protecting circuits operating below 5 volts, while adding minimal leakage current and capacitance. Semtech's proprietary EPD devices are utilized for circuits operating below 5V.

TVS diodes typically serve as parallel protection elements, connected between two signal lines or from line to ground. As the transient voltage rises above the operating voltage of the device, the TVS becomes a low impedance path diverting the transient current away from the protected device. ESD protection for data interface ICs is recommended at the signal line interfaces and power supply lines (Figure 1).

Selection of a suitable component will depend on the number of lines to be protected, the available board space, and the electrical characteristics of the circuit to be protected. TVS diodes are available in a variety of surface mount packages and configurations. In portable applications where board space is at a premium, TVS arrays such as Semtech's SMS series are available in six-lead SOT23 packages and protect up to

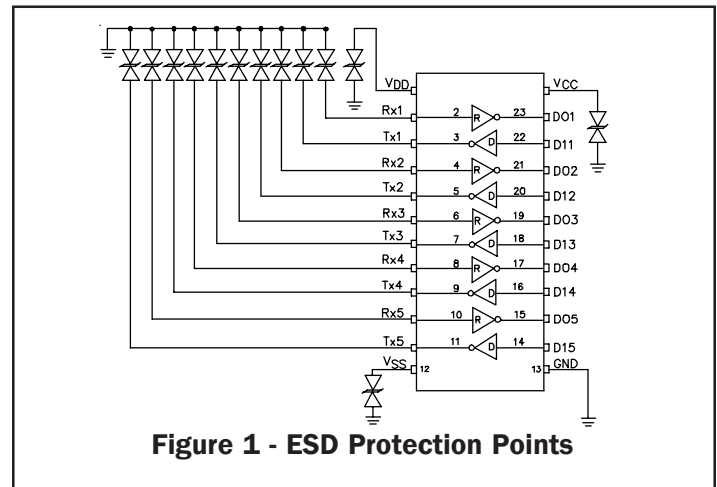


Figure 1 - ESD Protection Points

5 data and I/O lines. As electronics continue to shrink, available board space becomes even more of an issue. To address this, TVS arrays in even smaller packages are also available. The SMF05 and SMF12 TVS arrays for example, are designed to protect four lines and are housed in an extremely small SC-70 package.

The TVS diode capacitance must be considered in high-speed interface applications. Excess device capacitance can cause signal degradation or even signal reflections. For systems employing high-speed data lines, special low capacitance devices are available such as Semtech's LCDA and RailClamp® series.

PC board layout is an important part of transient immunity design. This is especially critical in systems where the threat of ESD exists. Parasitic inductance in the protection path can result in significant voltage overshoot and may exceed the damage threshold of the protected IC. Recall that the voltage developed across an inductive load is proportional to the time rate of change in current ($V = L di/dt$). An ESD induced transient reaches a peak in less than 1ns (per IEC 61000-4-2). Assuming a trace inductance of 20nH per inch and a quarter inch trace, the voltage overshoot will be 50 volts for a 10A pulse. All inductive paths must be considered including the ground return path, the path between the TVS and the protected line, and the path from the connector to the TVS device. Additionally, The TVS device should be placed as close to the connector as possible to reduce transient coupling into nearby trace. Finally, avoid running critical signal lines near board edges or next to protected lines.