Application Brief

ESD Protection for Keypads, Pushbuttons, and Side Keys

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Introduction

Buttons are some of the most basic parts in a system but tend to be the most necessary. Whether that is the letter 'm' on a keyboard or the 'eject' button in a fighter jet, there is a risk of an electrostatic discharge (ESD) event occurring. Since buttons have constant human interaction, adding an ESD protection diode to the system can protect the downstream circuitry from harmful transients. To certify the system is protected from any damaging ESD strikes, the characteristics of the button's interface must be considered when selecting the correct ESD protection diode.

Overview

Push buttons, keypads, and side keys are commonly found in many applications including cell phones, cars, and human machine interfaces (HMIs). These applications have high-contact areas that can present a low-impedance path for ESD to enter the system. Buttons are typically found on data lines with low speeds and low voltages. Due to the low signal speeds, capacitance of the ESD protection device is not a concern. Since there are a multitude of applications for these buttons, single or multichannel diodes with either a unidirectional or bidirectional polarity can be used depending on the particular application.

Causes of ESD

There are many sources of ESD including opening a plastic bag or walking across vinyl floor. This charge can build up and eventually discharge on an exposed connector that is present, including push buttons, keypads, and side keys. When a button is in contact with the outside world, the system is at risk of a high voltage strike. This ESD strike or transient event can cause damage to the downstream components in the system.

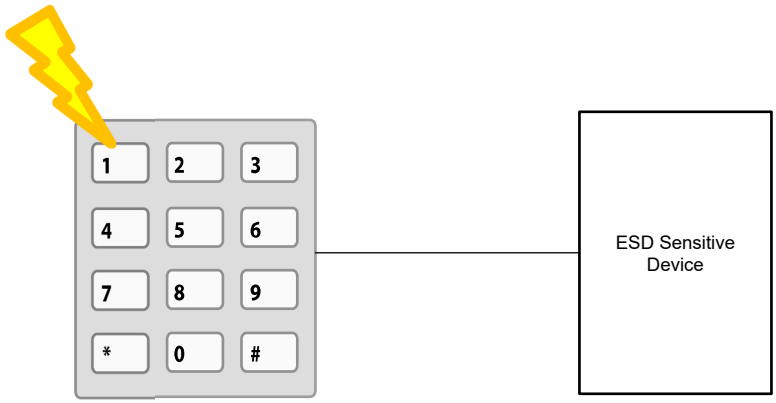

Figure 1. Keypad ESD Event

Buttons are high-contact areas with constant human interaction leaving the system vulnerable to ESD. Touching the contacts directly with a finger is not possible, but electrostatic discharge can occur through air-gap discharge and potentially damage the system.

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ESD Protection Requirements

To protect Keypads, Push buttons, and Side Keys, follow the list of parameters:

- Working Voltage
  - The reverse working voltage (V_{RWM}) of the protection diode must be greater than the operating voltage of the system being protected. For push buttons, keypads, and side keys, the typical operating voltage range is between 3.3 V and 5.5 V. This translates to a working voltage of greater than 3.3 V to 5.5 V.
- Polarity
  - A unidirectional or bidirectional diode can be used to protect the system. Unidirectional diodes are recommended when there is only a positive voltage on the line. Unidirectional diodes also clamp at a lower voltage for negative ESD strikes which is an advantage when the application has a low tolerance to negative voltage strikes. Bidirectional diodes are recommended when there can be either positive or negative voltages.
- Clamping Voltage
  - There can be many different systems utilizing a push button or keypad. This results in the clamping voltage of the ESD diode being dependent on the circuity downstream from the push button. If the downstream component has an absolute maximum rating for the pins of 12 V then the clamping voltage of the protection diode is recommended to be less than or equal to 12 V to protect the device.
- Capacitance
  - Since keypads, push buttons, and side keys are usually on low frequency data lines, the capacitance is not as important when selecting an ESD protection device.
- IEC 61000-4-2 Rating
  - Real-world ESD strikes are defined by the IEC 61000-4-2 testing standard. This standard consists of two measurements: contact and air-gap discharge. The higher the contact and air-gap rating, the higher the voltage a device can withstand. For push buttons, keypads, and side keys, a minimum IEC 61000-4-2 rating of 8-kV for contact is recommended. Since air-gap discharge is the more prominent form of ESD on buttons, an IEC 61000-4-2 rating of 15-kV or higher is recommended.

Table 1 lists devices that support these specifications.

System Level Designs

TI offers a range of ESD diodes with options to protect keypads, push buttons, and side keys. Figure 2 shows a push button block diagram implementing three ESD protection diodes. The diodes are connected to each data line between the push buttons and the ESD sensitive device. To properly protect the system, place the diodes as close to the source of ESD, in this case the push buttons, as design rules allow.

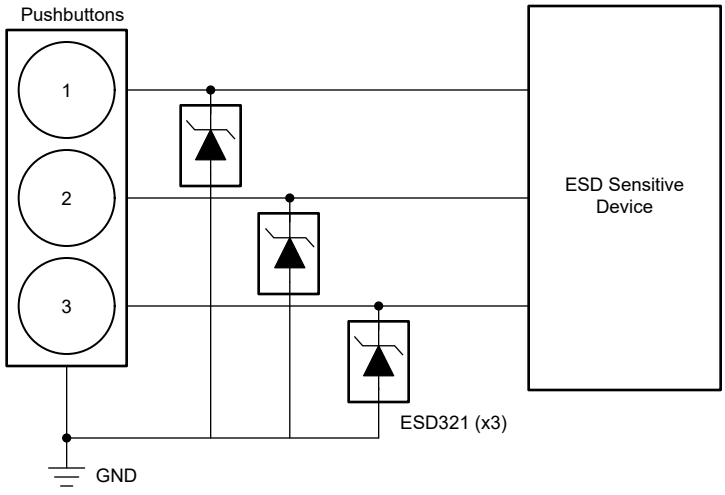

Figure 2. Push Button Placement Diagram

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For Figure 2, ESD321 is used to protect the downstream ESD sensitive device. ESD321 is a unidirectional device that is able to protect in the positive voltage direction. The clamping voltage for ESD321 is 6.8 V, so the absolute maximum rating for the pins of the ESD sensitive device is recommended to be greater than or equal to 6.8 V to provide protection.

For more information on ESD protection layouts, see the ESD Packaging and Layout Guide.

Summary

Keypads, push buttons, and side keys require ESD protection to survive real-world ESD strikes. Choosing the correct protection diode is crucial in maintaining system functionality and coverage in the event of a high voltage transient. The table below lists device recommendations for protecting keypads, push buttons, and side keys, and more devices can be found here.

Table 1. Device Recommendations

Device	V_{RWM} (V)	IEC 61000-4-2 (kV) (Contact/Air-gap)	Clamping Voltage (V)	Polarity	Package Size (mm)
TPD1E10B06	5.5	30/30	14	Bidirectional	DFN1006 (1.00 x 0.60), SOD-523 (1.20 x 0.80)
ESD321	3.6	30/30	6.8	Unidirectional	DFN1006 (1.00 x 0.60), SOD-523 (1.20 x 0.80)
TPD1E6B06	5	15/15	14	Bidirectional	DFN0603 (0.60 x 0.30)

References

- Texas Instruments, *System-Level ESD Protection Guide*
- Texas Instruments, *Reading and Understanding an ESD Protection Data Sheet*
- Texas Instruments, *ESD Packaging and Layout Guide*

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