

Introducing

PolyZen Device Fundamentals

PolyZen device is designed to help engineers conserve valuable board space and meet evolving safety and performance standards in the portable electronics, automotive, multimedia and lighting industries.

PolyZen Device Fundamentals

PolyZen Device Helps Protect Portable Electronics

The mobile functionality of today's portable equipment offers consumers an increasingly connected lifestyle. However, every time these products are connected or disconnected, they may be exposed to circuit damage caused by user error, wrong supply voltages, or voltage or current transients.

The Littelfuse PolyZen device is designed to help engineers conserve valuable board space and meet evolving safety and performance standards in the portable electronics, automotive, multimedia and lighting industries.

As shown in Figure 1, the PolyZen device incorporates a stable Zener diode for crisp voltage clamping and a resistively non-linear PPTC (Polymeric Positive Temperature Coefficient) layer. The PPTC layer responds to either diode heating or overcurrent events by transitioning from a low- to high-resistance state. In the event of a sustained high-power overvoltage condition, the tripped PPTC element limits current and generates voltage drop to help protect both the Zener and the follow on electronics - effectively increasing the diode's power-handling capability.

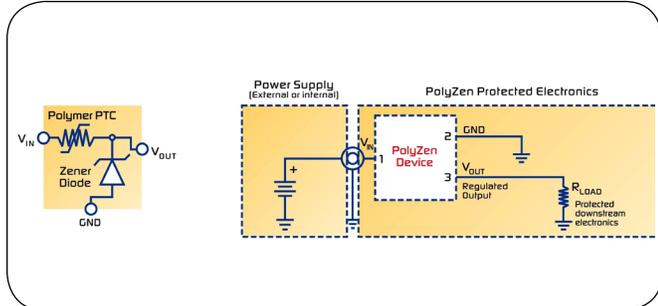


Figure 1. Littelfuse PolyZen device helps provide input power protection for portable electronics

PolyZen Device Helps Protect Equipment from Charger-Induced Failure

The widespread availability of external and universal power supplies has made charger-induced system failure a leading cause of device warranty returns. Designing in additional safeguards to help prevent damage that may be caused by the use of unauthorized charging systems is complicated by the fact that the solution itself must accommodate smaller electronic packages.

The most cost-effective way to implement a power bus for portable electronics is with a standard DC barrel jack. However,

because this connector is so commonly used, the user may accidentally connect the incorrect power supply to his/her electronics at home or while traveling. Faults may also occur when using commercially available universal power supplies that come with a variety of connectors. These devices allow the user to dial in the voltage to levels as high as 24V, as well as switch polarity.

Custom connectors can mitigate this risk, but they are expensive to tool; and with the proliferation of portable devices and universal power supplies they are often easily defeated. Third-party power converters may filter some transients, but testing by Littelfuse shows that their transient suppression capability varies widely. As shown in Figure 2, a device may experience voltage spikes as high as 88.5V (141V p-p) when connected to a poorly regulated, third-party charger.

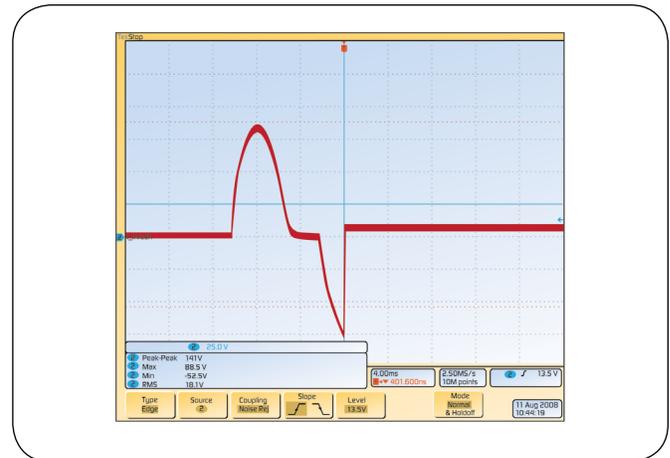


Figure 2. Voltage spike across a device connected to third-party charger
Max: 88.5V, Time period: 7ms

Transient Protection Design Considerations

Transient protection is especially critical when designing peripherals that may be powered off computer buses and automotive power buses. Automotive power buses are notoriously dirty. Although they are nominally 12V, they can range in normal operation from 8V to 16V. Still, battery currents can exceed 100 Amps and be stopped instantly via a relay or fuse, generating large inductive spikes on the bus and increasing voltage by 5 times or more.

In operation, automotive supplies are subject to damage from misconnected batteries and double battery jump-starts (24V). A condition known as "load dump" can also generate large voltages on the bus.

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Although typical computer power supplies provide regulated lines at 5V +/- 5%, and 12V +/-5%, under certain circumstances the voltage at these lines may exceed 5.25V and 12.6V, causing damage to the system or unprotected peripherals. Voltage spikes can occur when there is inductance in the power bus and a rapid change in current occurs.

This change can result from a hot disconnect of a peripheral, an internal system shutdown, or other internal power fluctuations. Inductance can be designed in with magnetics, but can also be generated by long cables and other power bus artifacts. The more inductance in the power bus, the worse the voltage spike experienced by the peripheral is likely to be. In short, portable consumer electronics exposed to voltages well in excess of the bus voltage may require protection to help prevent premature failure.

PolyZen Device Helps Protect USB Power Ports

The USB 3.0 “SuperSpeed USB” protocol was developed to provide higher transfer rates, increased maximum bus power and device current draw, new power management features, and new cables and connectors that are backward-compatible with USB 2.0 devices. The most significant change is that an additional physical bus has been added in parallel with the existing USB 2.0 bus.

Under the USB 3.0 specification, high-powered devices will be able to source up 0.9A of current, and new types of powering devices, such as Powered-B connector devices, may provide up to 1A, as opposed to 0.5A in the USB 2.0 specification. These higher current applications require more reliable and robust circuit protection to help prevent damage caused by overvoltage transients and overcurrent conditions.

Overvoltage transients are generally a result of ESD (Electrostatic Discharge) and may occur on both the power bus as well as the data lines. Overcurrent conditions can also affect the power bus. Because USB 3.0 increases normal operating current and current limits, USB overvoltage protection devices designed for traditional 0.5A ports may be inadequate for the new USB 3.0 specification. If a 0.9A host disconnects, high-voltage inductive spikes can be generated, which can damage devices left on the bus.

USB 3.0 will not support bus-powered hubs and will only support self-powered hubs. Since a power jack port is needed to power-up all connectors of the hub in USB 3.0 applications,

a circuit protection device is now needed at the power input to help protect the hub electronics from damage caused by overvoltage events, such as an unregulated or incorrect supply, reverse voltage or voltage transients.

Figure 3 shows how installing a PolyZen device on the VBUS and six low-capacitance ESD-protection devices on a typical USB circuit can help provide a coordinated overvoltage solution.

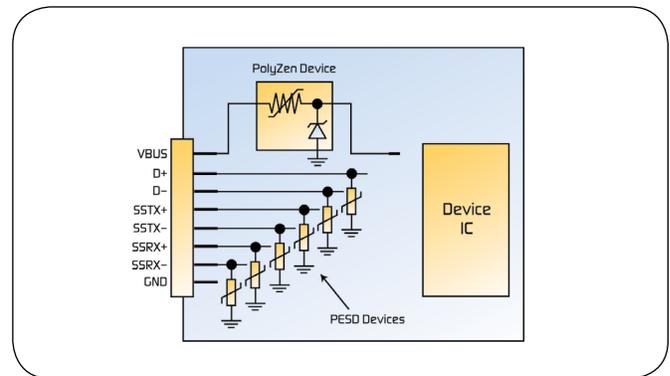


Figure 3. Coordinated device-side protection solution includes a PolyZen device and six low-capacitance ESD-protection devices.

Low Leakage-Current in Suspend Mode

Advances in semiconductor technology have increased chip density and operational frequency and, in portable device applications, have made power management a major concern. High power consumption affects battery service life, and even for non-portable devices, reducing power dissipation can help improve reliability and reduce cost.

Most portable electronics spend considerable time in the standby state, and because nearly all current and future handheld devices will be required to charge from USB sources, managing standby leakage current has become an important design consideration. Though typical standby modes consume less power than normal operating modes, they still result in leakage current from CMOS-based devices. That leakage current, if high enough, can wake the device from sleep mode.

All USB-compliant devices transition into suspend mode after they see a constant idle state on their upstream bus lines for more than 3mSec. The device draws a suspend current from the bus after no more than 10mSec of bus inactivity on all of its components. Some devices are capable of generating remote wake up signals, enabling the device to transition back to normal mode.

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For USB 2.0, the specification states that all devices (low- or high-power) must default to low power during suspend state. This means that low-power devices, such as flash drives or high-power devices such as external HDD's operating at low power, are limited to just 500uA of suspend current (1/1000th of the rated current during normal operation mode).

Devices capable of generating remote wake up signals are allowed (as per the specification) to draw up to a maximum of 2.5mA during suspend mode. This is true for configured bus-powered devices as well. Each available external port (up to 4 ports) is allocated 500uA and the remainder must be available for the hub and its internal functions.

Power management during suspend mode slightly differs for USB 3.0 host controllers and most of the supporting devices. All USB 3.0 devices may draw a current of up to 2.5mA during suspend mode. Bus-powered compound devices may consume up to 12.5mA suspend current – with 2.5mA suspend current for each port up to a maximum of 4 ports and 2.5mA suspend current for the internal hub and its functions.

The Littelfuse PolyZen device addresses the leakage current issue in suspend mode, and is suitable for overcurrent and overvoltage protection in all USB controllers and compliant devices.

How the PolyZen Device Works

The PolyZen device is particularly effective at clamping and smoothing inductive voltage spikes. In response to an inductive spike, the Zener diode element shunts current to ground until the voltage is reduced to the normal operating range. In the case of a wrong-voltage power supply, the device clamps the voltage, shunts excess power to ground, and eventually locks out the wrong supply, as shown in Figure 4.

The relatively flat voltage vs. current response of the PolyZen device helps clamp the output voltage, even when input voltage and source currents vary. Simply put, the PolyZen device helps provide coordinated protection with a component that protects like a Zener diode, but is capable of withstanding very-high-power fault conditions – without requiring any special heat-sinking structures beyond normal PCB traces.

PolyZen Device Features and Benefits

- Helps shield downstream electronics from overvoltage and reverse bias

- Trip events shut out overvoltage and reverse-bias sources
- Analog nature of trip events minimize upstream inductive spikes
- Helps reduce design costs with single component placement and minimal heat-sinking requirements
- Hold currents up to 2.3A
- Power handling on the order of 30 watts
- Stable VZ vs. fault current
- Time delayed, overvoltage trip
- Time delayed, reverse-bias trip
- Power handling on the order of 100 watts
- Integrated device construction
- RoHS compliant

Applications

- Cell phones
- Personal Navigation Device (PND)
- DVD players
- USB hubs
- Scanners
- Desk phones
- Personal Digital Assistants (PDA)
- MP3 players
- Digital cameras
- Printers
- Hard Disk Drives (HDD)
- PBX phones

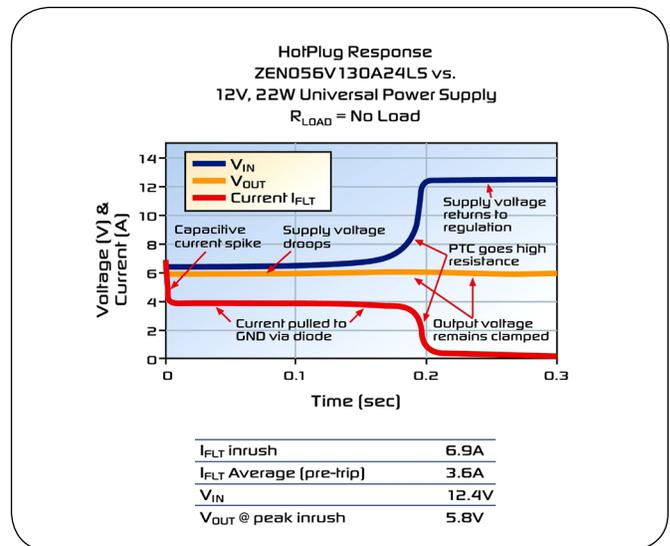


Figure 4. Polymer-enhanced Zener diode clamps and smoothes inductive voltage spikes.

Notice:

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