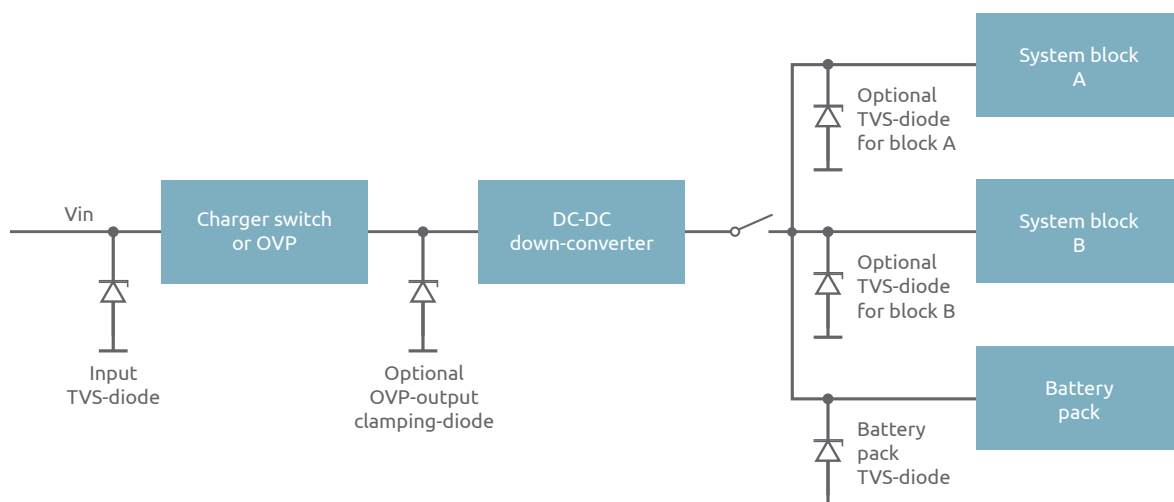


# What are TVS diodes and how do you choose the right one?

March 11, 2019 by Burkhard Laue

When it comes to medium-voltage high-energy pulses that last milliseconds, choosing the right TVS diode can be vital. Do you have the right protection for the typical surge events your system will face?



Signal lines and interfaces are designed with a specific voltage range tolerance. Within these limits, the system operates safely. However, when the safe operating area is exceeded, the system is vulnerable to disturbances or can even get damaged by exposure to strong transients.

High current surge pulses originate from external surge events through, for example, a charger or a cable, and from internal surge events like switching events and load changes. Discrete parallel protection solutions are necessary to short these surges to ground, promptly and recurrently. This blog addresses highly robust protection diodes meant for DC-lines or slow speed signal lines.

**Transient Voltage Suppressor or TVS diodes** are an effective solution to protect other semiconductors from any damaging surge levels they may be exposed to. Some confusion can arise as ESD diodes can often be referred to as TVS diodes in literature. However, there is a clear distinction. TVS diodes are particularly efficient in countering medium-voltage high-energy pulses that last milliseconds, in comparison to ESD protection devices which address higher voltage pulses of lower energy and shorter duration.

## From power lines to earphone jacks

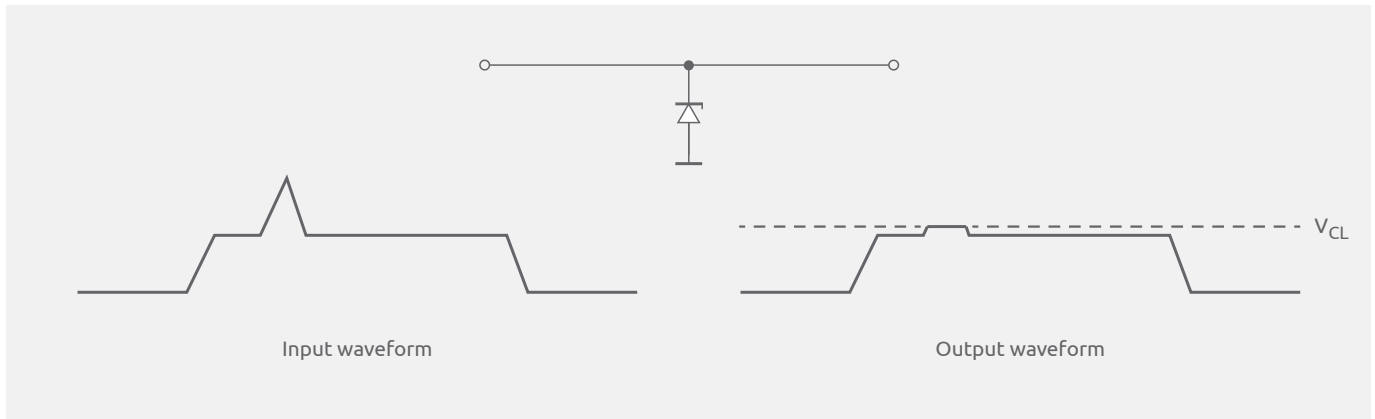
TVS diodes are available as unidirectional and bidirectional protection devices. The unidirectional types are perfect for protecting power supply lines and all kinds of charger ports. Bidirectional types can safeguard audio interfaces like earphone jack connectors (for example in [smartphones](#)).

Nexperia's offering includes TVS diodes for various surge parameters including high-surge pulse ratings. Our **PTVS** portfolio is designed to be placed on supply lines – and so can withstand significantly higher energy than ESD protection devices. TVS diodes can easily be selected by circuit operating voltage and peak pulse power requirements.

Ultimately, package preference is a key decision factor. For mobile and extremely space-constrained applications, types in small packages are vital. Whereas for computing, consumer and automotive applications, larger and more robust TVS diodes in clip-bond technology are more common. Nexperia's TVS diodes help minimize PCB footprint requirements for all applications by adjusting and optimizing the active junction area, while ensuring good system robustness testing results.

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EFFICIENCY WINS.



Operation of a TVS diode on a signal line

### How to choose the right solution

Choosing a TVS solution starts with context. Engineers need to distinguish requirements between board-level protection and primary design protection. Further, the types of transients expected to impact the circuit have to be considered – for example a lightning strike differs from voltage overshoots created by load change and non-perfect voltage relation. Temperature also plays a role in finding the right device: as temperature increases, the power rating of a TVS diode decreases.

With our product selector, simply start by looking at the Reverse Standoff Voltage or Reverse Working Voltage (VRWM or VWWM), which is the peak of normal DC operation in a circuit. Typically 15% higher than this value, the Reverse Breakdown Voltage (VBR) is the point where a TVS diode enters low-impedance mode thanks to avalanche breakdown. Once these two parameters are defined, review the Peak Pulse Current (IPP) of the TVS for typical waveforms at 8/20  $\mu$ s acc. to IEC 61000-4-5 and/or 10/1000  $\mu$ s acc. to IEC 41643-21 pulse testing. Clamping Voltage (VCL) requirements are derived from these values. When the voltage on the protected line reaches the TVS breakdown voltage, it will start conducting current to ground, resulting in the voltage being clamped to VCL. To select a suitable solution, make sure the VRWM is equal to or higher than VBus, but never surpass the VCC limits of any of the circuit's components.

### Surge pulses meet their match

With over 175 solutions in the [Nexperia TVS diodes range](#), our products can effectively dissipate the energy of various forms of surge pulses. Whichever TVS solution you choose, our devices offer reactive turn-on and low clamping, making these ideal to protect an extremely broad range of applications from [smartphones](#) and consumer electronics right up to [automotive](#) electronic circuits and 600 W systems.

For further information about supply line protection with TVS solutions, refer to our [ESD application handbook](#), and gain a deeper understanding of TVS placement in Chapter 8.6.

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