

Increase Reliability by Using Avalanche Diodes

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Description

Avalanche occurs in diodes when the voltage across a diode exceeds a specified value. An avalanche diode is a diode that is designed to break down and conduct at a specified reverse bias voltage. This is somewhat similar, but not identical to Zener breakdown.

When avalanche occurs in a typical diode or other semiconductor, it generally causes catastrophic failure. However, if the diode is designed to control the avalanche phenomenon, the diode can tolerate avalanche caused by overvoltage, and remain undamaged. Thus, avalanche type diodes are often used in protecting circuits against transient high voltages which otherwise would damage the circuit.

Avalanche breakdown is a phenomenon that can occur in both insulating and semiconducting materials. It is a form of electric current multiplication that can allow very large currents to flow within materials which are otherwise good insulators. Avalanche breakdown can occur within solids, liquids, or gases when the voltage applied across the insulating material is great enough to accelerate free electrons to the point that, when they strike atoms in the material, they can knock other electrons free.

Avalanche occurs extremely quickly, and as a result, avalanche diodes are the fastest surge-suppression devices. Applications include protection against transients, such as in high voltage or inductive circuits, and when putting diodes in series.

Applications for Avalanche Diodes

Avalanche type diodes can result in increased reliability in many applications, particularly those where voltage transients are expected. Due to its high speed and ability to withstand large numbers of transients, avalanche diodes are used to protect circuits against surges, lightning and other transients. They are faster than MOV's, zeners, and gas tubes.

Avalanche diodes are the diode type of choice in high voltage circuits, such as high voltage multipliers, due to possibility of transients caused by arcs, pulses, etc.

Another usage for rectifiers with avalanche capability is putting individual diodes in series to obtain higher reverse voltage capability. The voltage normally divides in proportion to the reverse resistance of each diode. Since there could be large variation in the reverse resistance, the voltage may not divide equally across the series string of diodes. A transient of sufficient amplitude will drive the voltage across one or more diodes into the breakdown region. A typical diode will exhibit catastrophic failure when this occurs. However, avalanche type diodes will cause the voltage to divide much more evenly. Also, the avalanche diode is capable of protecting itself by handling transient energy, providing it does not exceed the energy rating of the diode. Thus, whenever diodes are connected in series to increase the voltage rating, avalanche diodes should be used.

Inductive loads, upon interruption, generate voltage transients. Particular care should be exercised when specifying rectifiers for these applications, especially for the freewheeling diode placed across an inductive load. Motors, relays, solenoids and motor starters are typical of equipment, which are capable of rupturing ordinary silicon rectifiers. Unless it can be clearly shown that the peak inductive transient voltage cannot exceed the voltage rating of the diode, avalanche diodes are the preferred type for this application.

Summary

Avalanche diodes are designed to break down at a well-defined reverse voltage without being destroyed. Diodes designed to control this phenomenon are called avalanche diodes. They are well suited for use in protective applications, inductive circuits, high voltage circuits and when connecting diodes in series. In many applications, avalanche diodes will survive while normal diodes will fail. Thus, use of avalanche diodes in selected applications can result in improved reliability.

For Additional Information

A description of the differences between Zener and avalanche diodes can be found in "Zener and Avalanche Breakdown/Diodes" at http://people.deas.harvard.edu/~jones/es154/lectures/lecture_2/breakdown/breakdown.html

A more in-depth description of reverse bias breakdown, including the avalanche and Zener processes is at http://ece-www.colorado.edu/~bart/book/book/chapter4/ch4_5.htm

A description of transient protection can be found in "Lightning and Surge Protection" at <http://www.arcelect.com/lightnin.htm>

Also see [Wikipedia](http://en.wikipedia.org), from which an excerpt was included above.

One manufacturer of avalanche diodes is [Edal Industries](http://www.edal.com).

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