Diode Specifications

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Sept. 1, 2008

The purpose of this note is to familiarize the student with some important specification concerning diodes. The student should study manufacture's data sheets and application notes to obtain more complete understanding. The specifications are divided into limits and characteristics. Limits must not be exceeded. Characteristics are things to be aware of.

Limit specifications

Maximum forward continuous current The product of forward voltage drop and current through the diode is the power dissipation of the diode. Power dissipation results in a temperature rise. The maximum temperature that a diode can operate is around 125 C although some parts can operate at over 150 C. It is always good to operate any component below its maximum rated temperature. Be very aware that the specification assumes that the diode is operated with an infinite heat sink attached. No such heat sink exists and you must de-rate the specification based upon the actual heat sink characteristics and ambient temperature. This very important step is often overlooked and the result is diode failure from overheating even if the diode is operated below the specified maximum.

Maximum forward surge current This specification generally applies to power rectifier diodes and addresses the turn-on transient current when large filter capacitors have to be rapidly charged. This specification is usually several times higher than the continuous current rating but only applies if the duration is brief.

Maximum forward peak current This specification generally applies to power rectifier diodes and addresses the fact that conduction through the diode is only for a small percentage of the total AC cycle time. As an example, a one ampere DC average current might require brief peak currents of ten amperes or more. The peak currents cause local hot spots which can damage the diode if they exceed the maximum temperature.

Maximum reverse voltage In the reverse direction the diode is an insulator but only if the reverse voltage is not too high. There is some voltage at which the diode structure breaks down and considerable reverse current can result which will usually destroy the diode instantly. The rating is often given as PIV for Peak Inverse Voltage. It is always a good idea to choose a diode with a significantly higher PIV rating than the maximum reverse voltage it will experience as this provides a safety margin. See manufacture's application notes.

Reverse recovery time Because of some complex physics, a diode that has been conducting in the forward direction will briefly conduct in the reverse direction. This results in extra heat being generated in power rectifiers and limits how high the AC frequency can be.

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Maximum junction temperature This is the maximum temperature that the diode junction should be operated at. It is often in the 125 to 150 C range.

Characteristic specifications

Forward voltage This is generally given as a maximum at one or more operating currents.

Reverse leakage current This is how much reverse current may exist under reverse bias conditions. It is a measure of imperfections in the manufacturing process and has no relation to the reverse saturation current which is many orders of magnitude smaller.

Turn-on or turn-off time This is generally given as the maximum number of nanoseconds (sometimes picoseconds) for the diode to switch between forward and reverse operating conditions.

Junction capacitance This parameter is generally given in picofarrads at some operating point. The capacitance is inversely related to the depletion region width and decreases with reverse voltage and increases significantly with forward current.

Thermal resistance This is an important specification for removing heat from the diode. Thermal resistance has units of degrees C per watt and the value from the junction to the case is provided and the value from case to ambient is provided. For small diodes that are rarely mounted in a heat sink the value from junction to ambient is often provided. An external heat sink can significantly lower the thermal resistance from the case to ambient. As an example, if a small diode has a thermal resistance from junction to ambient of 180 C/W then if the diode is dissipating 0.5 watts then the junction temperature will be (0.5 * 180) or 90 C above ambient.