Practical Consideration for Maximum Operating Temperature

Every SSDI semiconductor product comes with a data sheet that provides key electrical characteristics, maximum ratings, mechanical properties and important features of the device. In this paper, one of the key maximum ratings - Operating Temperature - will be discussed.

The operating temperature can be found in the maximum rating table and is oftentimes joined with storage temperature. The difference between the two is the former is under power and the latter is not. As far as SSDI data sheets are concerned, operating temperature is the same as junction temperature, which is the temperature of the semiconductor chip or die inside the package. It should not be confused with case temperature or lead temperature as these refer to a location on the outside surface of the package. Case temperature usually refers to the backside of the package, the side that goes against a heatsink. As for lead temperature, this refers to one of the electrically active leads that carries power to a load.

The operating temperature is given as a range, for example -55 °C to +175 °C, and should not be exceeded at any point in time during operation. Operating above the maximum limit could cause the part to fail, compromise its reliability or shorten its useful life (premature failure).

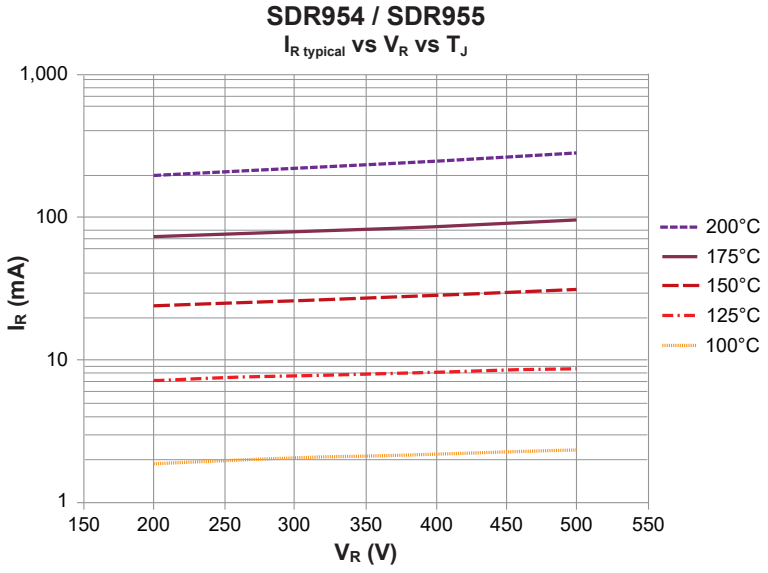
There are certain devices that are rated at 200 °C and have high leakage current as well. Examples of these are the high voltage, ultrafast rectifier, SDR12U080, and the high voltage, hyperfast rectifier, SDR954. Their maximum operating temperature is only realized under ideal conditions, i.e., device mated to an infinitely large and highly efficient heatsink. Of course, in real world applications this is not possible and therefore, the actual operating temperature must be derated. This is more so true for the SDR954 due to its very high leakage current which approximately doubles every 10 °C rise (see Figure 1). When operated at high temperature, it will generate enough power during the off cycle to cause the junction temperature to rise some more which in turn will cause the leakage current to increase further. If not properly controlled, this regenerative effect will lead to thermal runaway and ultimately destroy the device. So, it is important to derate the actual operating temperature from the maximum rating, utilize an adequate heatsink for the application or derate the reverse voltage to lessen the power dissipation during the off cycle.

Use the following formula to calculate the operating (junction) temperature. It is apparent from the formula that TJ will always be higher than TC under powered condition.

$TJ = (PD * \Theta J\text{-}C) + TC$

- TJ = operating (junction) temperature, should be derated from maximum operating temperature
- PD = average power dissipation
- TC = case temperature, steady state
- ΘJ-C = Junction-to-case thermal resistance, given in maximum rating table of datasheet

Figure 1



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