AN6147

Use of Rectifier Diodes at Elevated Temperatures for Short Term Overloads

Replaces AN6147-1

AN6147-2 March 2016 (LN33413)

Introduction:

In many applications the rating of the semiconductor is determined by the overload conditions rather than the normal continuous running operation. If the overload condition is of a short duration, of the order of one minute, then rectifier diodes can be operated at above their maximum rated junction temperature as long as the repetitive voltage is reduced.

Use of rectifier diodes at elevated temperatures

Many of the characteristics of a rectifier diode are temperature dependent, but for modest increases in junction temperature many of these changes are insignificant. However the leakage current will approximately double for every 10°C rise in junction temperature as illustrated in figure 1.

This increase in leakage current combined with the repetitive voltage VRRM will result in increased power dissipation and potential thermal run-away of the equipment. By reducing the repetitive voltage the power dissipation during reverse blocking can be reduced to an acceptable level and the equipment allowed to ride out the overload without any problems. In this Application Note a method of estimating voltage de-rating is outlined.

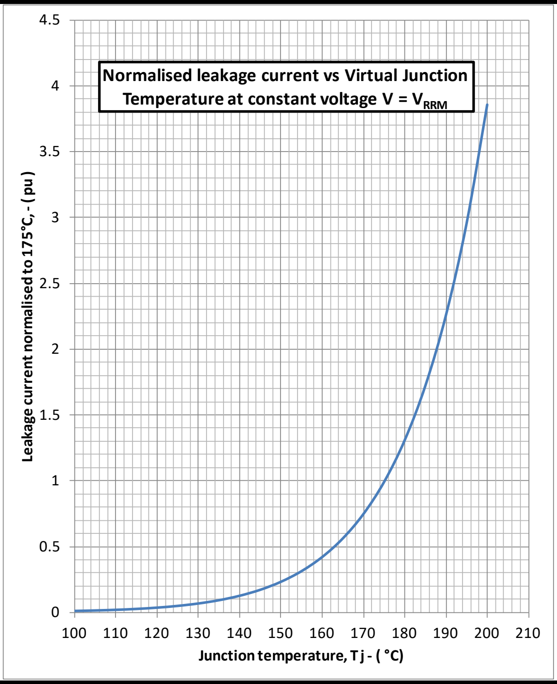

Fig. 1 Leakage current vs junction temperature

Fig. 2 shows the typical effect of voltage on leakage current. The leakage current is reduced by 50% if the voltage is reduced to 80% of VRRM. Thus we can see that if the junction temperature approaches 190°C but we keep the VxI product constant by reducing the voltage to 75% of VRRM, the power dissipation will remain constant.

By combining Figure 1 with the inverse of figure 2 we obtain the useful graph given in fig 3. Voltage blocking of 50% VRRM at 200° has been verified in the laboratory.

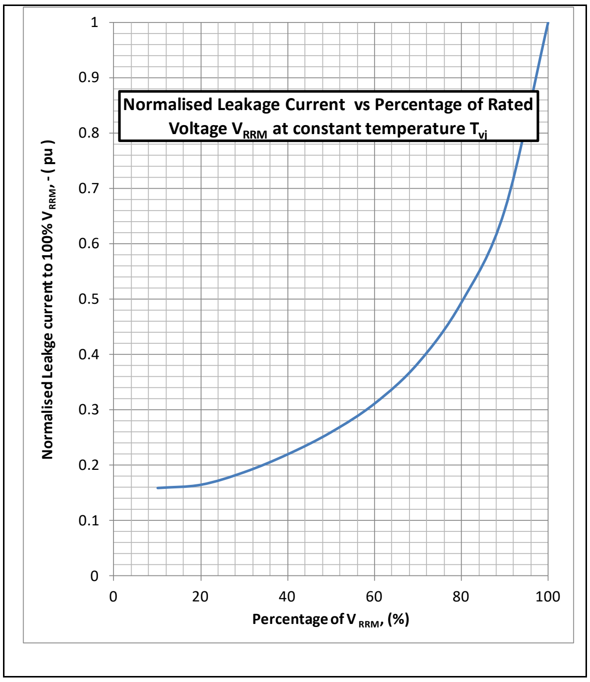

Fig.2 Leakage current vs % of the repetitive voltage VRRM

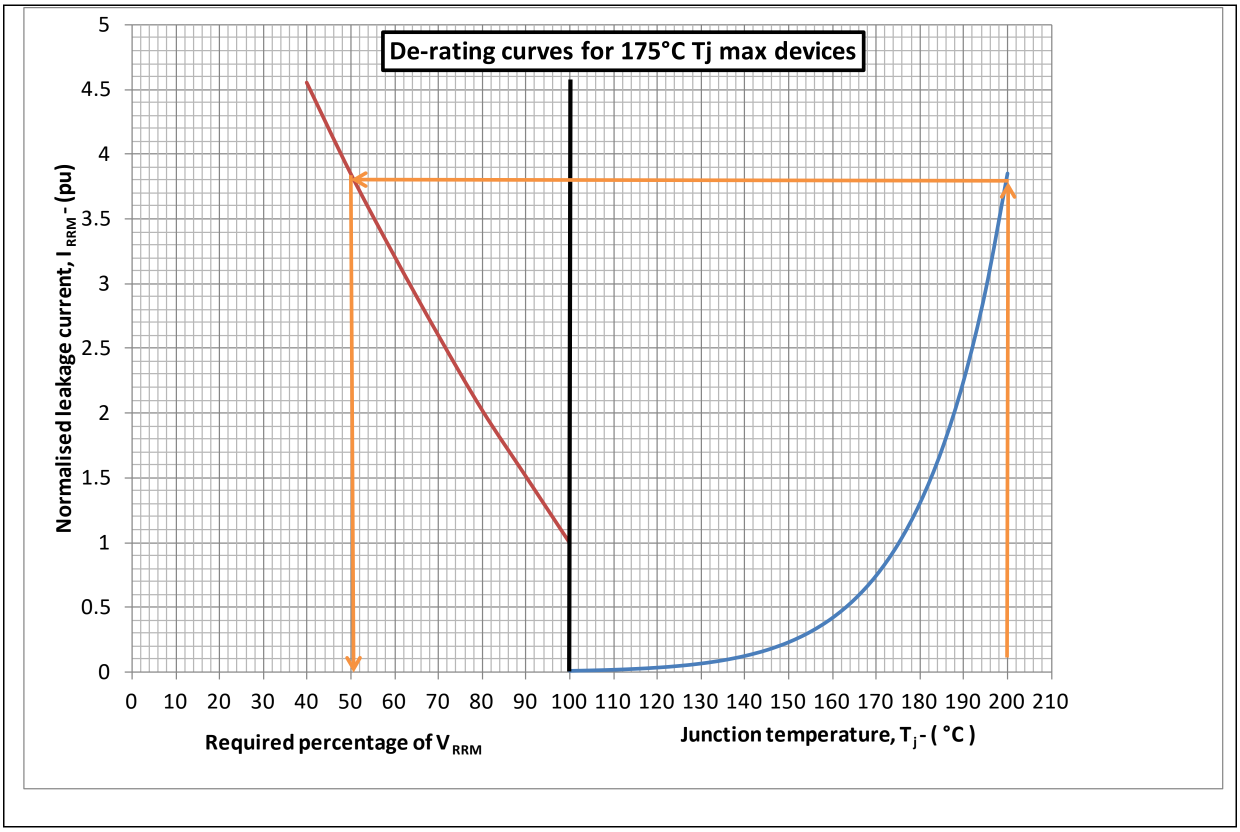

Fig3. Required percentage of VRRM for rectifier junction temperatures above 175°C

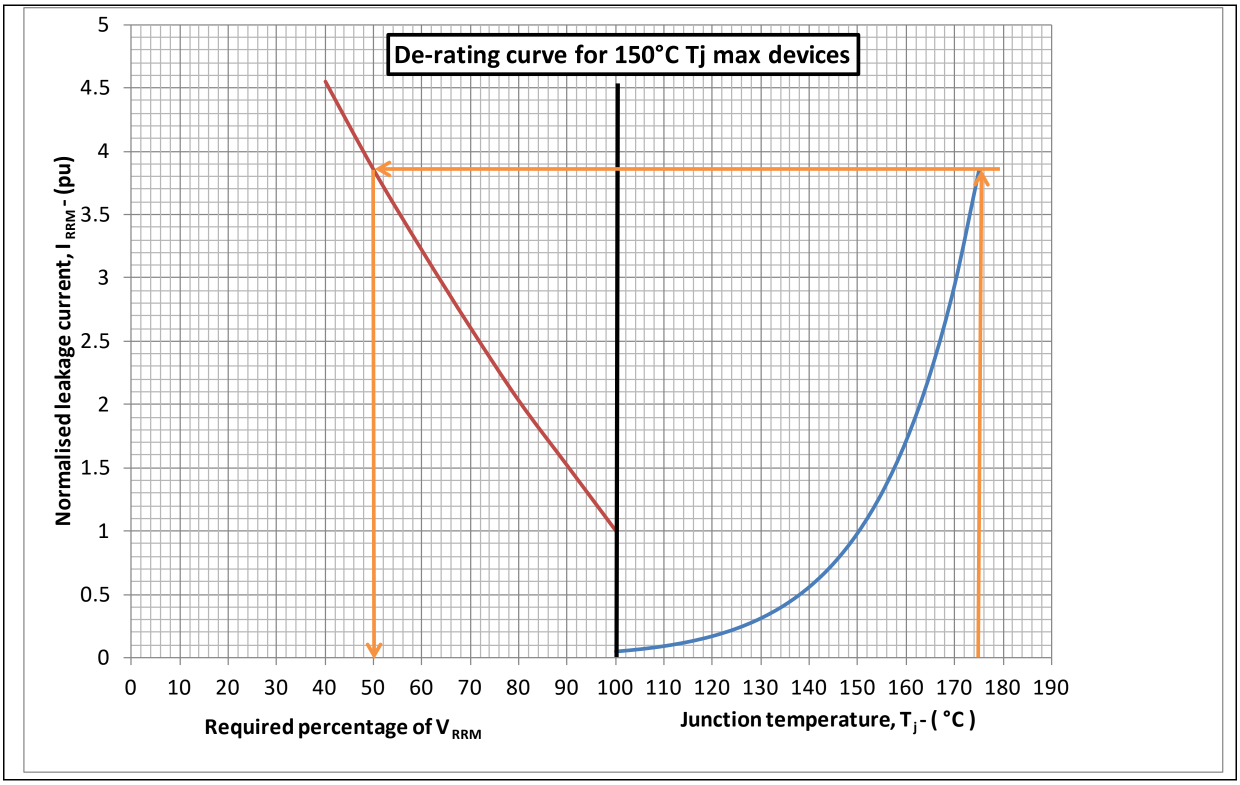

Figure 4 Required percentage of VRRM for rectifier junction temperatures above 150°C

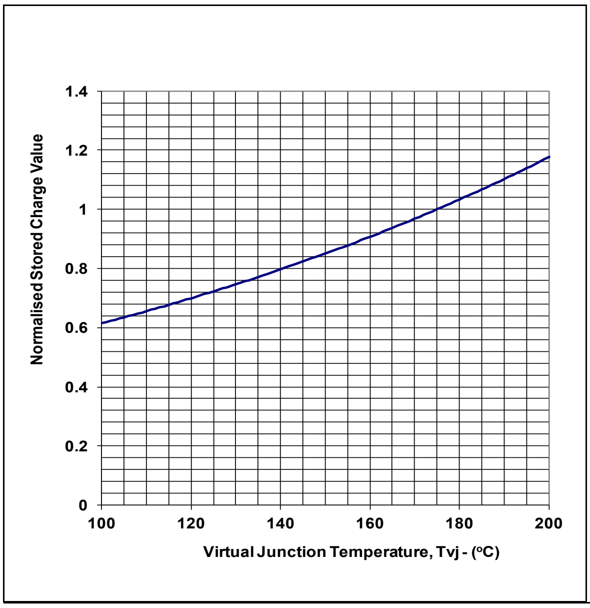

Fig 5 Stored Charge against Junction Temperature

Unfortunately, stored charge is a strong function of temperature as shown in fig.5 so the reverse recovery losses and the voltage overshoot during reverse recovery will also increase so the snubber design should also be reviewed to ensure that the diode is still operating within safe limits. Forward voltage drop may also increase. This can be seen by observing the cross-over point of the Vfm characteristics in the datasheet compared to the operating current. A linear extrapolation of the interval between the datasheet curves will give a reasonable approximation.

These additional increases in conduction and recovery losses may mean that V_{RRM} has to be further reduced to maintain device thermal stability.

The leakage current of a reverse biased diode is comprised of two components, the diffusion based current and the thermally generated current. At around 220°C, depending upon the resistivity of the silicon used to make the diode (or the avalanche voltage of the diode), the diffusion based current begins to dominate and the relationship between current and temperature changes so that this analysis no longer applies.

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