SGS-THOMSON MICROELECTRONICS

APPLICATION NOTE

THE CONDUCTION LOSSES IN A POWER RECTIFIER

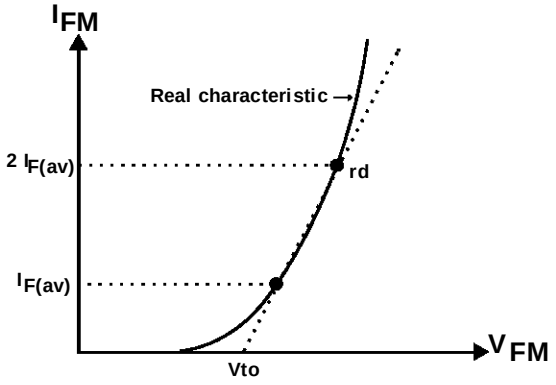
B. Rivet

INTRODUCTION

In spite of the high operating frequency, the conduction losses remain the main cause of the junction's temperature increase in the majority of the applications. Therefore, it is important to accurately estimate these losses.
The purpose of this note is to give data to calculate the conduction losses in the diodes.

The forward characteristic of a diode is shown in fig.1

Fig.1 : Forward characteristics of a diodes



I_F(av) : Average forward current of the diode

We can define two areas :

1) The peak current I_M is lower than 3 $I_{F(av)}$:

The forward characteristic of a diode may be assimilated to a straight line defined by Vto and rd (Fig.1).

The forward voltage can be expressed by

$$V_{FM} = Vto + rd\ I_{FM}$$

Vto and rd are given in the datasheet for each part number. With this model the expression of the conduction losses is :

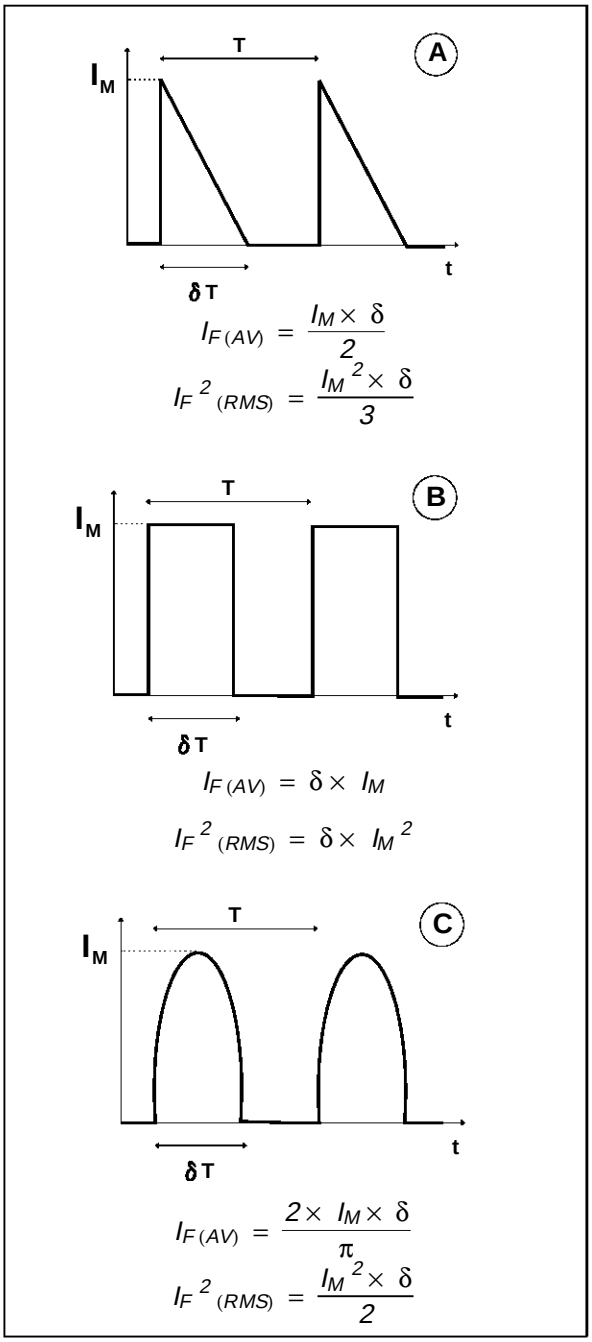
$$Pcond = Vto\ I_{F(av)} + rd\ I_F{}^2{}_{(RMS)}$$

$I_{F(av)}$: average forward current in the diode

$I_{F(RMS)}$: RMS forward current in the diode

Fig.2 shows the average and RMS values for different current wave forms.

Fig.2 : Average and RMS values for different currents wave forms.



Example :
With a STTA1206D : Vto = 1.15V rd = 0.029 Ohm
and a rectangular current : I_M = 20A δ = 0.5
we find :

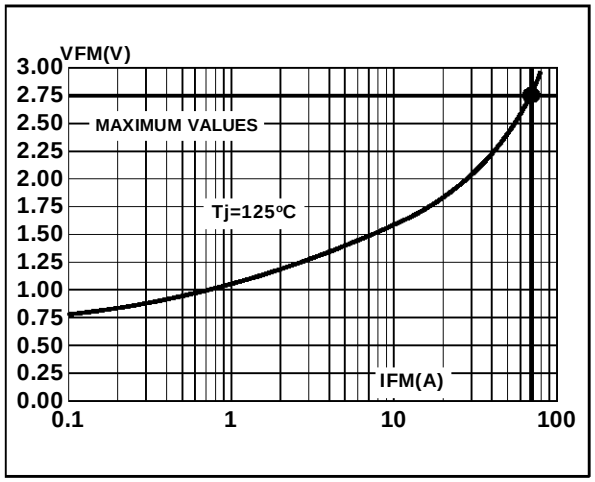
Pcond = 17.3W

2) The peak current I_M is higher than 3 $I_{F(av)}$:

When the peak current I_M is higher than 3 $I_{F(av)}$, the forward voltage and the conduction losses values calculated with Vto and rd becomes very pessimistic (Fig.1).

A more accurate estimation of the conduction losses can be done with the curve V_{FM} , I_{FM} given in the datasheet (fig.3).

Fig.3 : Forward voltage drop versus forward current of a STTA806D.



In the case of a rectangular current conduction losses can be expressed by :

$$Pcond = V_{FM}(I_M) \times I_{F(av)}$$

Where V_F (I_M) is the V_{FM} value when $I_{FM} = I_M$

Example :
With a rectangular current : I_M = 70A δ = 0.1
and a STTA806D V_{FM}(70A) = 2.75V (Fig.3)
Pcond = V_{FM}(70A) x δ x I_M
we find :

Pcond = 19W

In these conditions, conduction losses calculated with Vto and rd give : Pcond = 29W !

Conclusion

This short note provides the designer with the rules to properly estimate the conduction losses in a power diode. It also highlights the limitation of the traditional forward characteristic model V_F = Vto + rd I_F, gives a value very pessimistic at high level current.