AN1768
APPLICATION NOTE

ADMISSIBLE AVALANCHE POWER OF SCHOTTKY DIODES

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INTRODUCTION

The design of Switch Mode Power Supply (SMPS) is subjected to ever increasing cost and efficiency constraints.

One way to respond to these aggressive specifications is to use components closer to their intrinsic limits.

The increasing use of Schottky diodes in the avalanche area is a good example of this evolution.

To help the designer to optimize the choice of the Schottky diode in a rectification application, STMicroelectronics is proposing a simple tool to determine if a given ST Schottky diode can withstand the avalanche energy fixed by the application conditions.

1. DESIGN RULES

The first step for the designer is to estimate, in the worst-case conditions, the following parameters:

- Operating junction temperature: Tj
- Pulse duration of the avalanche current: tp
- Avalanche energy by pulse generated by the converter in the Schottky diode: E_{AP}

STMicroelectronics guarantees for each Schottky diode a reference avalanche power given at tp=1µs and Tj=25°C: P_{ARM}(1µs,25°C) (corresponding to a rectangular current pulse).

Table 1 gives P_{ARM}(1µs,25°C) for some part numbers.

Table 1: P_{ARM}(1µs, 25°C) values for some ST Schottky diodes.

Part number	P_{ARM}(1µs; 25°C) per diode
STPS1545D (2x7.5A)	2.7 kW
STPS2045CT (2x10A)	4 kW
STPS3045CT (2x15A)	6 kW
STPS20H100CT (2x10A)	10.8 kW

Derating curves *figure 2* and *figure 3* give the admissible avalanche power versus tp and Tj.

P_{ARM}(1µs, 25°C) for each part number as well as the derating curves are given in the respective datasheet.

The designer must ensure that the guaranteed avalanche energy E_{ARM}(tp,Tj) is greater than the avalanche energy in the application E_{AP}.

Fig. 2: Avalanche power derating over temperature range.

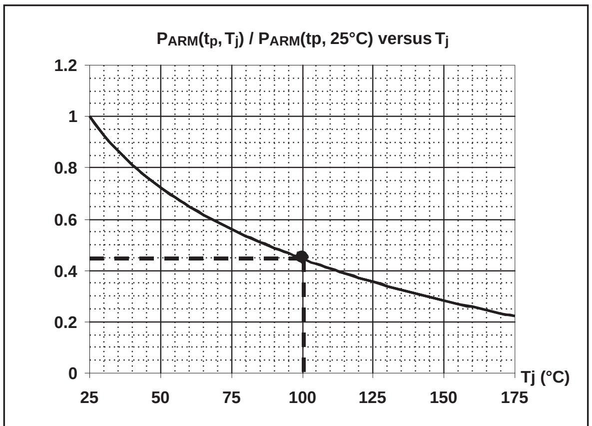
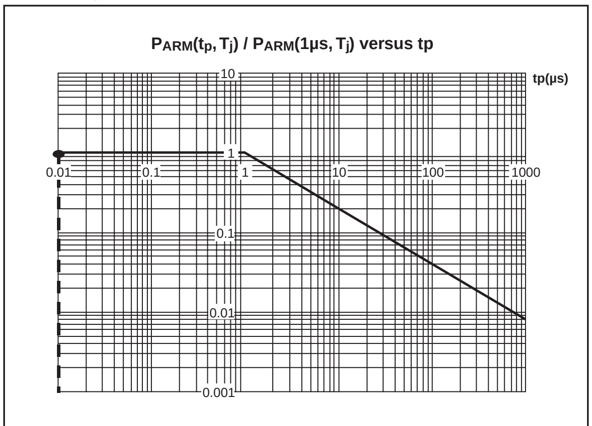


Fig. 3: Avalanche power derating over pulse duration range



2. DESIGN EXAMPLE

Let us consider the use of a STPS20H100CT (two 10A, 100V ST Schottky diodes in TO-220 package) used in a flyback converter (*figure 4*).

Fig. 4: Topology of a flyback converter.

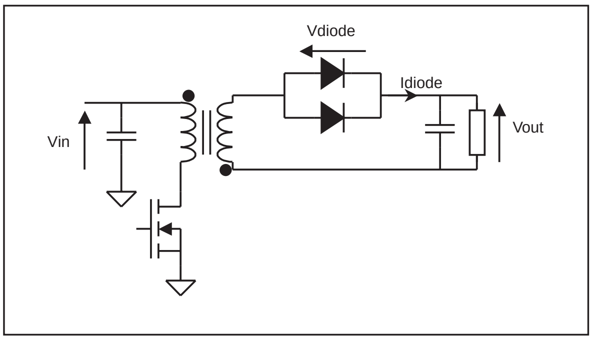
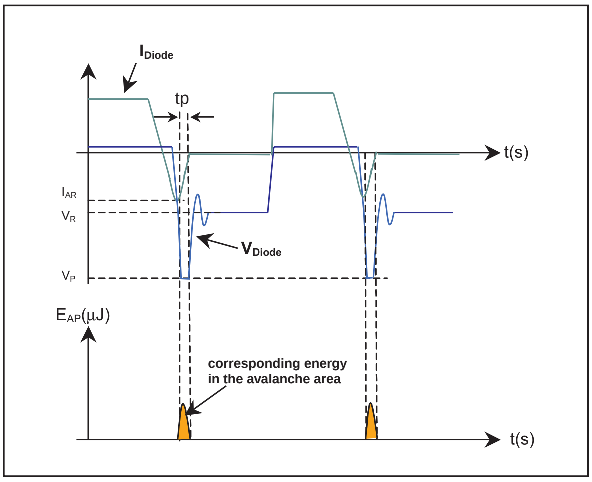


Figure 5 shows the corresponding current and voltage waveforms through the two diodes.

Fig. 5: Current and voltage waveforms through the two diodes.
(I_{AR} = repetitive avalanche current)



In a **typical worst-case situation**, the application conditions are:

- Operating junction temperature of the Schottky diode:

Tj = 100°C

- Pulse duration of the avalanche current:

tp = 10ns

- Avalanche energy by pulse through the two diodes connected in parallel:

V_P = -130V, I_{AR} = -1.5A, tp = 10ns
⇒E_{AP} = 1.95µJ

- Table 1 gives:

$P_{ARM}(1\mu s, 25°C)_{STPS20H100CT}$ = 10.8 kW per diode

- Figure 2 gives: $\frac{P_{ARM}(tp,100°C)}{P_{ARM}(tp,25°C)} = 0.45$

⇒$P_{ARM}(1\mu s,100°C) = P_{ARM}(1\mu s,25°C) \times 0.45$
⇒$P_{ARM}(1\mu s,100°C)$ = 4.86 kW

- Fig.3 gives: $\frac{P_{ARM}(10ns,T_j)}{P_{ARM}(1\mu s,T_j)} = 1$

⇒$P_{ARM}(10ns,100°C) = P_{ARM}(1\mu s,100°C)$
⇒$P_{ARM}(10ns,100°C)$ = 4.86 kW

Finally,

$E_{ARM}(10ns,100°C) = P_{ARM}(10ns,100°C) \times 10ns$

The maximum admissible avalanche energy of the STPS20H100CT at 10ns and 100°C is:

E_{ARM}(10ns,100°C) = 48.6µJ per diode

Consequently, as the guaranteed value E_{ARM}(10ns,100°C) (per diode) is higher than E_{AP} measured through the two diodes connected in parallel (48.6µJ > 1.95µJ), the STPS20H100CT will withstand the avalanche energy generated by the converter.