

Application Note  
SBR<sup>®</sup> Avalanche Energy

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**1.0 Introduction**

The maximum reverse avalanche rating, or  $P_{ARM}(T_J)$ , of a power diode is an important element in a power supply application. It is used in determining a power diodes' ability to safely handle relatively large reverse power levels as seen in power supply applications. This application note is intended to allow designers to optimize the efficiency of their power supply by choosing the correct output rectifying diodes that are closer to their intrinsic voltage breakdown limit. This will give designers the most optimal forward voltage ( $V_F$ ) with the insurance of a reliable rectifier that can withstand the peak avalanche surges that come with a power supply.

**2.0 SBR<sup>®</sup> Avalanche Energy**

Due to the absence of a metal barrier, the SBR<sup>®</sup> has a significantly greater avalanche capability compared to the standard Schottky diode. Table 1 shows a comparison of the maximum peak-pulse reverse surge current ( $I_{RRM}$ ) and the avalanche energy capability  $E_{AS}$  of the SBR20U100CT compared to existing Schottky rectifiers in the market. The SBR20U100CT reverse avalanche capability drastically outperforms both Company A's (Tier-1) and Company B's (Tier-1) Schottky diodes. This significantly increases the reliability of the SBR<sup>®</sup> diodes against any large reverse surge currents.

Vendor	Part No	Max $I_{RRM}^*$ (A)	Max Avalanche Energy $E_{AS}^{**}$ (mJ)
Competitor A	Device A	0.5	24
Competitor B	Device B	1	120
Diodes, Inc.	SBR20U100CT	3	205

\* 2uS, 1kHz Repetitive Squarewave Pulse

\*\* As tested,  $T_J = 25\text{ }^\circ\text{C}$ , IAS = 2 A, L = 12 mH

**Table 1. Peak-Pulse Reverse Surge Current ( $I_{RRM}$ )**

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**3.0 How to Design for the Correct Avalanche Energy**

To determine the correct avalanche energy for a rectifying diode in a power supply, the designer must obtain or estimate the worst-case scenario for the following two parameters:

- (1) Avalanche Energy ( $E_A = V_{RM} * I_{RM} * t_p$ ), where  $V_{RM}$  is the avalanche voltage,  $I_{RM}$  is the avalanche current, and  $t_p$  is the avalanche pulse duration
- (2) Operating Junction Temperature ( $T_J$ )

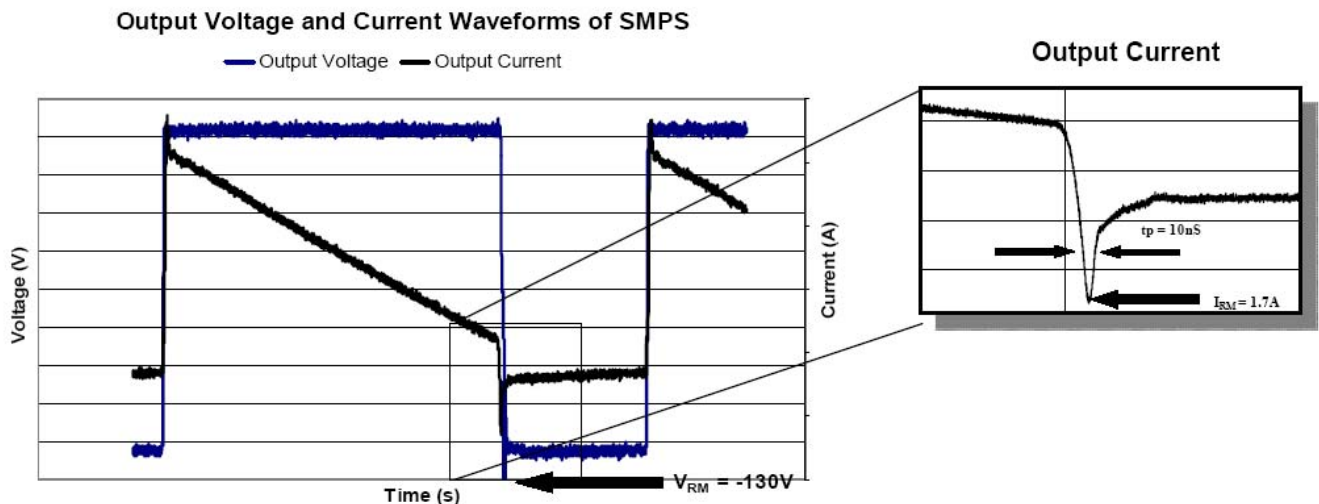
For an output rectifying diode to reliably withstand the avalanche surge currents,

$$E_A < P_{ARM}(T_J) * t_p \quad (\text{Eq. 1})$$

Where  $E_A$  is the avalanche energy of the power supply,  $P_{ARM}(T_J)$  is the maximum avalanche power of the output rectifier, and  $t_p$  is the duration of the avalanche surge of the power supply.

**4.0 Design Example**

Figure 1 shows an example of an output waveform from a rectifying diode in a typical flyback power supply.



**Figure 1. Output Waveforms of a Typical Flyback Power Supply**

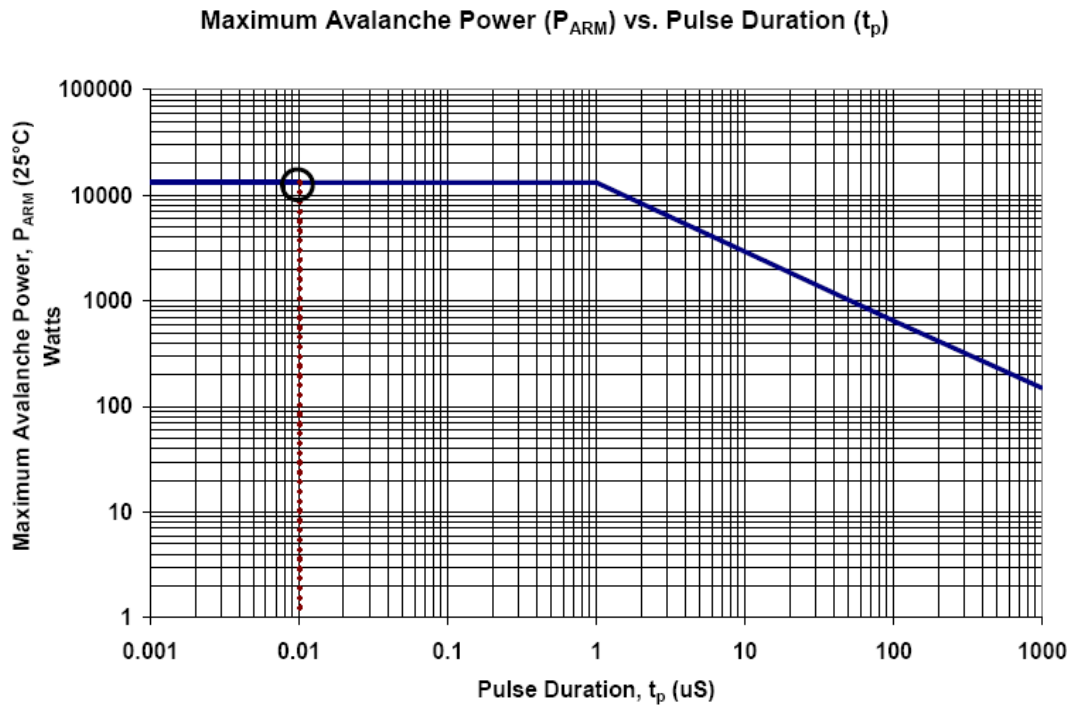
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From Figure 1, the avalanche energy  $E_A$  can be calculated to be equal to 2.2uJ, where:

$$V_{RM} = -130V, I_{RM} = -1.7A, \text{ and } t_p = 10nS.$$

The maximum avalanche power,  $P_{ARM} (T_J)$ , can be found by using the maximum avalanche power chart of the SBR20U100CT product datasheet as illustrated in Figure 2.



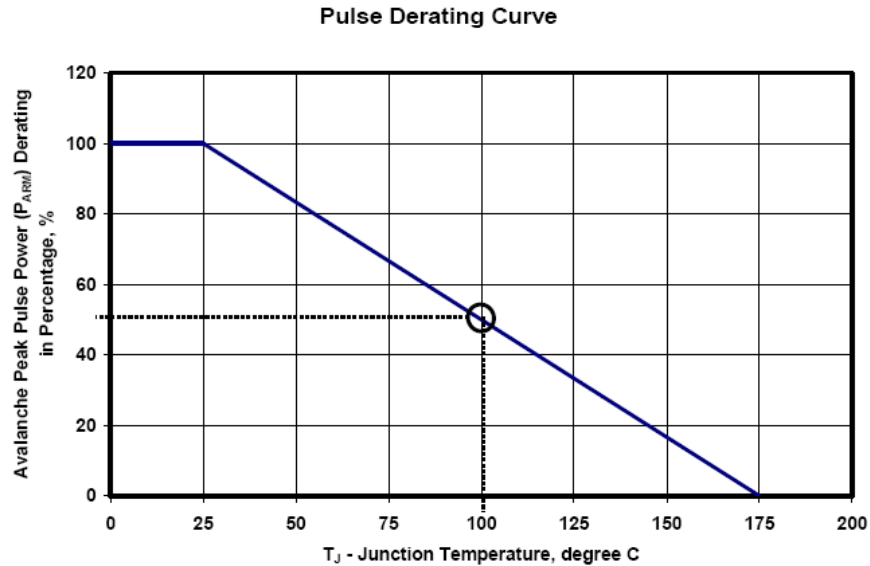
**Figure 2. Maximum Avalanche Power ( $P_{ARM}$ ) vs. Pulse Duration ( $t_p$ ) of SBR20U100CT**

At 10nS, the  $P_{ARM} (25^\circ C)$  is equal to 13.2kW.

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Assuming that the operating junction temperature of the rectifying diode is 100°C, the derating ratio is equal to 50% as shown in Figure 3 from the SBR20U100CT product datasheet.



**Figure 3. Pulse Derating Curve for SBR20U100CT**

$P_{ARM} (100^{\circ}\text{C})$  is equal to the derating ratio \*  $P_{ARM} (25^{\circ}\text{C})$ .

$$P_{ARM} (100^{\circ}\text{C}) = 0.5 * 13.2\text{kW} = 6.6\text{kW}$$

Finally, using equation (1),

$$EA < P_{ARM} (T_J) * t_p \quad (\text{Eq. 1})$$

shows that,

$$2.2\mu\text{J} < (6.6\text{kW}) * 10\text{nS} = 66\mu\text{J}$$

From this calculation, one can be certain that the SBR20U100CT can withstand the avalanche energy produced by this power supply.

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#### **5.0 Conclusion**

With the SBR<sup>®</sup> having the ability to sustain more than twice the reverse avalanche energy of an equivalent Schottky diode, designers can now be sure that their circuit is adequately protected against any large reverse surges. More so, if the above guidelines are followed, designers can use this distinct reverse avalanche advantage of the SBR<sup>®</sup> to precisely design for the most optimal breakdown voltage for the output rectifying diode to improve the overall efficiency and reliability of their power supply.

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