SGS-THOMSON MICROELECTRONICS

APPLICATION NOTE

LOW FORWARD VOLTAGE SCHOTTKY DIODE

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INTRODUCTION

In power supplies, the major portion of power losses is due to output rectifiers. The impact of these losses on the efficiency can be expressed by :

$$\eta = \frac{V_{F\,(IOUT)}}{V_{OUT}}$$

η : efficiency drop due to the diodes.
$V_{F(IOUT)}$: voltage drop at the output current (IOUT) of the converter.
V_{OUT} : output voltage of the converter.

This formula shows that the influence of the forward voltage increases when the output voltage of the power supply decreases.

This parameter becomes very important for the new standard of 3.3V output voltage. Another key parameter is the leakage current which we have to take into account to develop high efficiency low forward voltage drop Schottky with the best trade-off.

1. TRADE-OFF

The 3 most important application characteristics of a Schottky are :

- forward voltage
- reverse leakage current
- reverse blocking voltage

Generally for a given application, the first step is to fix the reverse blocking voltage. We then study the best trade-off (choice of a metal barrier) between the forward voltage and the leakage current.

A decrease of the forward voltage increases the efficiency of the converter but increases at the same time the leakage current and limits operating range where we can keep the reverse losses under control. In the datasheet this range is defined by Tj max.

To define the best trade off of a low forward voltage schottky we have to take into account its application condition. SGS THOMSON has developed two families of low forward voltage Schottky well suitable to two applications : the OR-ing Schottky and Schottky for 3.3V output power supply secondary.

2. SCHOTTKY DIODES FOR 3.3V SWITCHED MODE POWER SUPPLY

When a Schottky works in a switched mode power supply (forward, flyback,...), it sees during the same switching period conduction losses and reverse losses.

In these configurations the trade-off between the forward voltage and the leakage current has to be chosen to have the best efficiency with a sufficient safety margin. This is to keep the reverse losses under control (Tj max = 125°C).

For these applications we need a breakdown voltage of 25V. Table 1 shows the main characteristic of these Schottky.

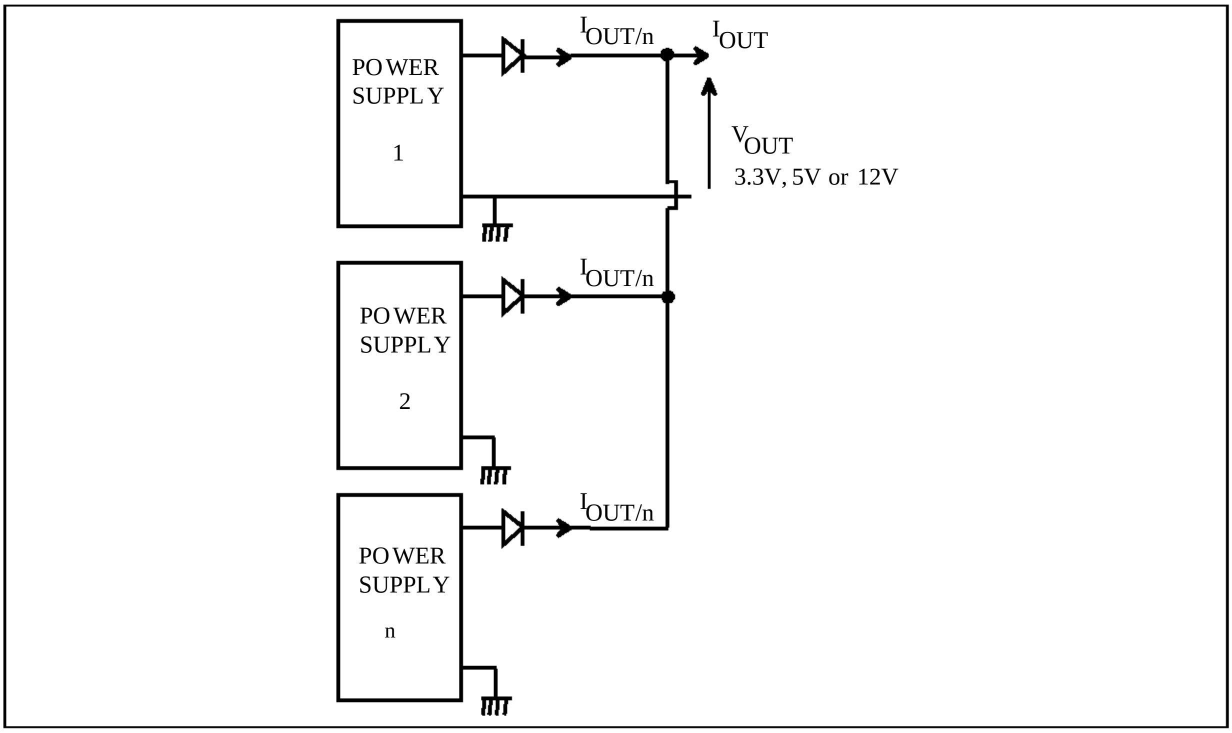
PART NUMBER	PACKAGE	Io	V_F (Io,125°C)		I_R (125°C, 25V)
			typ	Max	Max
		A	mV	mV	mA
STPS125U	SOD6	1	390 (1)	460 (1)	2 (1)
STPS5L25B	DPAK	5	310	350	175
STPS10L25D	TO220AC	10	300	350	400
STPS15L25D/G	D2PAK/TO220AC	15	300	350	640
STPS20L25CT	TO220AB	2x10	300	350	400
STPS20L25CG	D2PAK	2x10	300	350	400

Table 1 : Main characteristics of the 25V low V_F Schottky

3. OR-ING SCHOTTKY

To increase system reliability, power supplies are sometimes connected in parallel (Fig.1).

Fig.1 : OR-ing Schottky in redundant power supply



The Schottky diodes are connected in series with the output of each power supply. In the steady state a continuous current (I_{OUT}/n) flows in each Schottky. Obviously in this case there are no reverse losses.

When a power supply fails, the corresponding OR-ING diodes ceases to carry current and the system output voltage is not disturbed. The OR-ing diode then sees the reverse voltage V_{OUT}.

In this application the most critical parameter is the forward voltage drop in order to maintain the best efficiency of the system. A breakdown voltage of 10V is sufficient for output voltage of 5V and 3.3.V.

The trade-off has been chosen to obtain a low forward voltage. In this application we can accept a high leakage current because when the diode is blocked the reapplied voltage is low (3.3V or 5V), the junction temperature is also low because there are only reverse losses. So it's easy to keep reverse losses under control.

Table 2 gives the main characteristics of the 10V and 15V schottky.

PART NUMBER	PACKAGE	Io	V_F (Io,100°C)		I_R (100°C, 10V)
			typ	Max	Max
		A	mV	mV	A
STPS15L10D	TO220AC	15	270	320	0.42
STPS80L10TV	ISOTOP	2x40	270	320	1.2
STPS20L15D	TO220AC	20	0.31 (1)	0.36 (1)	0.55 (2)
STPS40L15CW	TO247	2x20	0.31 (3)	0.35 (3)	0.55 (2) Per diode

(1) : I=19A (2) : V_R=12V (3) : I=19A per diode

CONCLUSION

The equilibrium between efficiency and safety margin against thermal runaway has been best solved with 25V, 15V and 10V Power Schottky diodes. One being suitable for 3.3V supplies and the other for the redundant Powers supplies.

Moreover, the inclusion of Power Factor correction will significantly change the choice of the Schottky diode for the secondary Power supply rectification.

With PFC, the reapplied voltage across the output rectifiers will be lower. For example we can consider using 25V Schottky in a 5V forward converter, whereas today a 45V Schottky diode is needed.