SIRECT
ELECTRONIC

Brief of Schottky Barrier Diode

Friday, 7 August 2009

Schottky Barrier Diode

Schottky Barrier Diode (SBD) indeed more and more extensively to putting to use on Switching-Mode Power Supply (SMPS) in stead of Fast Recovery Epitaxial Diode (FRED). Not only the highest Reverse Recovery Time (trr) but also the lowest Forward Voltage Drop (V_F), both are the most important advantages on the high frequency application. The exchange (switching) and conduction losses on SMPS influenced by above two characteristics of SBD and then obtained the best efficiency on the application. Below is the comparison sheet of Rectifier Diode.

Type	V_{BR} (V_{RRM})	V_F	t_{rr}
Schottky Barrier Diode	15V-200V	0.3V-0.8V	<10ns
Super Fast Diode	50V-600V	0.8V-1.2V	25ns-35ns
Ultra Fast Diode	50V-1,000V	1.35V-1.75V	50ns-75ns
Fast Recovery Diode	50V-1,000V	1.2V	100ns-500ns
Standard Recovery Diode	50V-1,000V	1.0V	1μs-2μs
Bridge Rectifier	50V-1,000V	0.95V-1.3V	1μs-2μs
Transient Voltage Suppressor	5V-400V	-	-
Zener Diode	2.75V-180V	-	-
Switching Diode	35V-250V	1.0V-1.25V	1ns-6ns

Table 1: Electronic category of Rectifier Diode

Key Parameters

The key parameters deciding the process of SBD are barrier height (ϕ_B), high temperature Leakage (HTIR), forward voltage drop (V_F) and die size. The barrier height is the physical property of nature metal. At present, platinum (Pt), molybdenum (Mo) and chromium (Cr) are the general metal to use to the barrier on SBD. Also alloy can putted to use on specially type such as low V_F SBD.

Barrier Height (ϕ_B) = (-KT/q) Ln (J_O/R*T)

Where: ϕ_B = Barrier Height

K = Boltzmann's Constant

6.82 X 10-5ev/°C

q = Electron Charge

= 1 when using B.C.

T = Ambient Temp in OK

J_O = Current Density at 0 Volts

Io/Active Area (cm^2)

R* = Richardson's Constant

112A/cm^2 $^0K^2$

Sales Representatives:

U.S.A. -
113 Barksdale Professional Center in the City of Newark, County of New Castle, Delaware
e-mail: sgc@sirectsemi.com

China -
Room 302, Block A, Nanfangguoji Plaza, Yitian Rd. 3013, Futian district, Shenzhen, China
e-mail: candy@sirectifier.com.tw

Taiwan -
19F-3, NO. 75, Sec. 1, Xintai 5th Rd., Xixhi City, Taipei, Taiwan
e-mail: se@sirectsemi.com

Thailand -
29/123 F.8 Siam Condo. Rama 9 Rd., Huaykwang, Bangkok 10310, Thailand
e-mail: th@sirectsemi.com

www.sirectsemi.com

Molybdenum Barrier

The molybdenum barrier is extensively used for SMPS applications because of their lower cost and average electronic parameters. The Mo barrier SBD is generally targeted for the common SMPS devices (for example, for PC power, charger and adaptor). It must be mentioned, though, that an appropriate heat sink must be utilized to dissipate heat from the component and guarantee that its temperature is always below safety levels while under operation. Indeed, Mo barrier SBD devices have the reputation of being a little more unreliable at higher working temperatures when compared with Pt barrier devices.

Chromiun Barrier

The main advantage of the Chromium barrier device is that has the lowest V_F value compared with others and is suited for all kinds of portable and DC to DC applications. On the other hand, the disadvantage of the Cr barrier SBD is its relatively lower $T_{j(max)}$ capability, V_B value and an extremely high leakage current (I_R) even at room temperature.

Platinum Barrier

The platinum barrier SBD has very strong points besides its high V_B and $T_{j(max)}$ capabilities. Its lower leakage current (I_R) at room and working temperatures has also made it the best design choice for self-contained devices that are usually sealed and therefore operate at higher temperatures than normal, such as adaptors, open-frame and non-fan type power supplies. The Pt barrier SBD is usually used as the secondary rectifier component instead of the FRED owing to its better performance in efficiency and temperature. Besides this, noise and electromagnetic interference (EMI) considerations also make the Pt barrier SBD useful than the FRED.

High Temperature Leakage (H_{TIR})

The higher high temperature leakage (H_{TIR}) made the bigger losses and noise on power supply. Therefore, appropriate and lower reverse current leakage is very important for secondary application of power supply.

Forward Voltage Drop (V_F)

The conduction loss of power supply indeed influenced by forward voltage drop (V_F) and then, Low V_F SBD is the excellent solution for designer of SMPS. Indeed, low V_F SBD is the future star since the new requirement of high efficiency such as CEC level V and 80 Plus.

Maximum Junction Temperature, $T_{j\,(max)}$

The Maximum Junction Temperature, $T_{j\,(max)}$, always based on the barrier height of metal and Guard-Ring of diode. That is usually around 125°C-175°C. Below is the calculate formula of Tj.

Sales Representatives:

U.S.A. -
113 Barksdale Professional Center in the City of Newark, County of New Castle, Delaware
e-mail: sgc@sirectsemi.com

China -
Room 302, Block A, Nanfangguoji Plaza, Yitian Rd. 3013, Futian district, Shenzhen, China
e-mail: candy@sirectifier.com.tw

Taiwan -
19F-3, NO. 75, Sec. 1, Xintai 5th Rd., Xixhi City, Taipei, Taiwan
e-mail: se@sirectsemi.com

Thailand -
29/123 F.8 Siam Condo. Rama 9 Rd., Huaykwang, Bangkok 10310, Thailand
e-mail: th@sirectsemi.com

www.sirectsemi.com

$$T_J = T_A + [R_{\theta JA} \times P_R]$$

The $R_{\theta JA}$ is the total thermal resistance from junction to ambient and the P_R is the reverse power

A comparative illustration of reverse power versus junction temperature for various thermal resistance and ambient conditions is provided in Figure 1 for the typical behavior of Schottky rectifiers with a TJ(MAX) rating of 150°C.

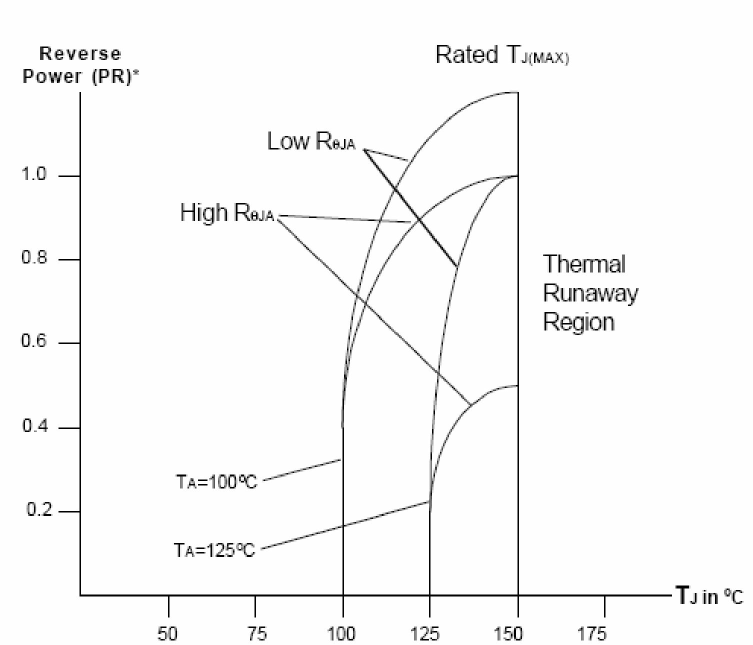

FIGURE 1

Typical Reverse Power vs. Junction Temperature for Schottky Rectifiers rated with $T_{J(MAX)}$ of 150°C

* Power Normalized to 1.0 for rated $I_O \times V_F$. The Io is rated average forward current and V_F is the forward voltage at Io

Die Size

Die size must be decide by the mask of wafer and we must choice the correct and economic die size subject to efficiency and cost. Die size of rectifier diodes usually decided by rated working current (maximum average rectified current, I_O) and maximum peak forward surge current (I_{FSM}). For example, uaually 35 mil square for 1 ampere and 90 mil square for 10 ampere.

Reverse Recovery Time (t_{rr})

The most important advantage of SBD is the extremely faster reverse recovery time (t_{rr}). Therefore, the characteristic of fast switching speed of SBD made the lower loss of switching possible. The trr of SBD usually less than 10 nanosecond (ns).

Guard-Ring

The guard ring of silica around the edge of dice reducing the reverse current due to edge effects and absorbs reverse transient energy. That is to say, guard ring of diode reducing reverse current leakage and increasing the energy when working especially on the environment of high temperature.

Sales Representatives:

U.S.A. -
113 Barksdale Professional Center in the City of Newark, County of New Castle, Delaware
e-mail: sgc@sirectsemi.com

China -
Room 302, Block A, Nanfangguoji Plaza, Yitian Rd. 3013, Futian district, Shenzhen, China
e-mail: candy@sirectifier.com.tw

Taiwan -
19F-3, NO. 75, Sec. 1, Xintai 5th Rd., Xixhi City, Taipei, Taiwan
e-mail: se@sirectsemi.com

Thailand -
29/123 F.8 Siam Condo. Rama 9 Rd., Huaykwang, Bangkok 10310, Thailand
e-mail: th@sirectsemi.com

www.sirectsemi.com