Micro Commercial Components

MCC Note
Series A001

Introduction to Schottky Rectifiers

Schottky rectifiers have been used for over 25 years in the power supply industry. The primary advantages are very low forward voltage drop and switching speeds that approach zero time making them ideal for output stages of switching power supplies. This latter feature has also stimulated their additional use in very high frequency applications including very low power involving signal and switching diode requirements of less than 100 picoseconds. These require small Schottky devices with low capacitance.

The reverse recovery time of Schottky diodes are extremely fast (but soft) recovery characteristics. What little reverse recovery time they may exhibit is primarily dictated by their capacitance rather than minority carrier recombination as in conventional pn junction rectifiers. This characteristic provides very little reverse current overshoot when switching the Schottky from the forward conducting mode to the reverse blocking state.

The combination of very "fast-soft switching properties" of a Schottky can also eliminate the need for snubber circuits in many applications that may otherwise be required with fast or ultrafast rectifiers displaying abrupt recovery characteristics. These features make schottky rectifiers a very attractive choice for low parasitic switching losses.

Design considerations with Schottky devices are limited in some applications compared to pn junction rectifiers because their reverse leakage currents are many times higher. Also Schottky rectifiers have maximum rated junction temperatures typically in the range of 125°C to 175°C, compared to the typical 200°C for conventional pn junctions which further influences leakage current behavior.

For some applications, Schottky devices are limited in available reverse blocking voltage ratings compared to conventional pn junction rectifiers. Nevertheless with judicious selection, many applications are optimized with Schottky rectifiers and their unique operating characteristics. Schottky rectifiers seldom exceed 100 volts in their working peak reverse voltage (V_{RWM}), since devices moderately above this rating level will result in forward voltages equal to or greater than equivalent pn junction rectifiers.

The Schottky rectifier properties described above are primarily determined by the metal energy barrier height of material deposited on the silicon by the manufacturer. A metal with a low energy barrier height will minimize forward voltage, but will also be restricted in its high temperature operating capability and have very high reverse leakage currents. A high barrier metal height selection will minimize temperature and leakage current sensitivity but will increase the forward voltage.

Depending on the application requirements, these design features can be used as a tradeoff in proper choice when selecting a schottky rectifier using different barrier metals from a manufacturer.
MCC Corporation offers a variety of barrier metal options on an n-epitaxial layer over a low resistivity substrate for optimizing parametric performance in addition to a protective guardring and passivation. This configuration is shown in Figure 1. A reliable schottky junction is designed with a pn junction guard ring to

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terminate the perimeter with a diffused p region. This also serves as a transient voltage suppressor for reverse energy absorption and over-voltage protection in close proximity to the Schottky junction. This perimeter region effectively is driven into avalanche breakdown before the Schottky is damaged by excessive amounts of reverse current flow and energy during transient events.

The voltage-current device protective relation is illustrated in Figure 2 along with the typical electrical parameters specified for Schottky rectifiers. In some cases, Schottky rectifiers are also specified with a reverse avalanche energy test. This will help ensure a safe level of operation in very fast switched applications resulting in high Ldi/dt inductive (such as transformer) voltage kicks or other sources of over-voltage transients that can briefly drive the Schottky beyond its maximum rated V_{RWM}. In such applications, these special reverse energy requirements should be requested for additional screening by the user when not otherwise specified.

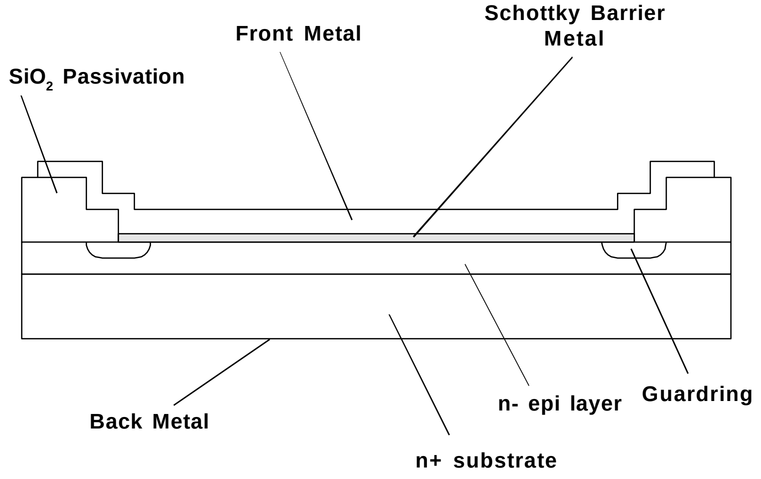

Figure 1
Vertical structure of Schottky Rectifier Die

PARAMETERS SPECIFIED AT 25˚C

- V_F Forward Voltage at I_F
- I_F Forward Current
- V_{RWM} Working Peak Reverse Voltage
- I_{FSM} Forward Surge Current Maximum (Specified non-repetitive 8.3ms, 1/2 sine)
- I_R Maximum Leakage Current at V_{RWM}
- V_{BR} Not Specified (Typically 20% to 30% higher than V_{RWM})