Silicon Carbide Diodes

650V/1200V 3rd Generation SiC Diodes

The TRSxxx65H, TRSxxx120H, and TRSxxx120HB Series utilize Toshiba's latest Silicon Carbide (SiC) Schottky Barrier Diode (SBD) process. These 3rd generation SiC diodes use a new Schottky metal, optimizing the Junction Barrier Schottky (JBS) structure of the 2nd generation products: This lowers the electric field at the Schottky interface and reduces leakage current to enhance efficiency. The components provide an industry-leading low forward voltage V_F of 1.20V (typ.) for 650V and 1.27V (typ.) for the 1200V class, which is 17% lower than the previous generation. Seven of the 650V class devices are housed in TO-220-2L packages, while the remaining five are provided in compact, flat DFN8x8 SMD packages. Five of the 1200V class devices are housed in TO-247-2L packages, and an additional five in TO-247-CT packages. The new diodes are specifically intended for use in efficiency-critical industrial equipment applications.

Applications

- Power supplies for
  - Servers
  - Telecoms
  - Industrial equipment
- Energy storage systems
- EV- charger (off board)
- Solar-Inverter

Features

- **Lowest V_F : 1.2V (typ.) for 650V class**
  1.27V (typ.) for 1200V class
- Good trade off of V_F and Q_c
- Low reverse current I_R
- High peak forward surge current

Advantages

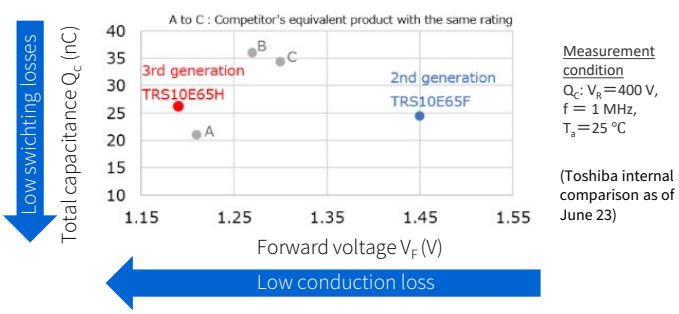
- Low forward losses
- Low diode losses
- Low reverse losses
- More design head room

Benefits

- High efficiency
- Less heat generation
- Robust product performance

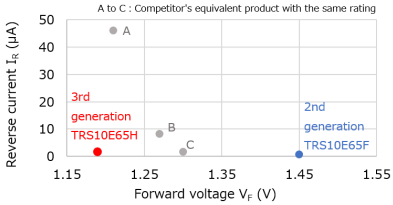
V_F x Q_c Trade–off improvement at 650V Diode example

Besides an extremely low forward voltage (V_F) of 1.20V (typ.), total capacitive charge (Q_C) is the second most important parameter for diode efficiency. Balancing the combination of both parameters will enable the highest efficiency operation.



Low reverse current (leakage current) at 650V Diode example

By adopting a Junction Barrier Schottky (JBS) structure even through lower forward voltage, Toshiba SiC Diodes manage to achieve a lower reverse current (I_R) similar to our 2nd generation.

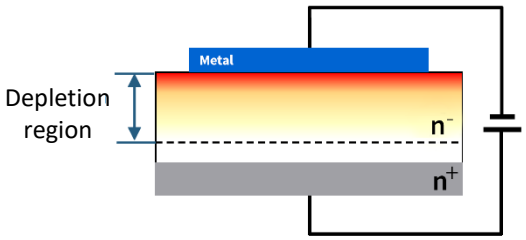


Measurement condition
I_R: V_R = 650 V, T_a = 25 °C

(Toshiba internal comparison as of June 23)

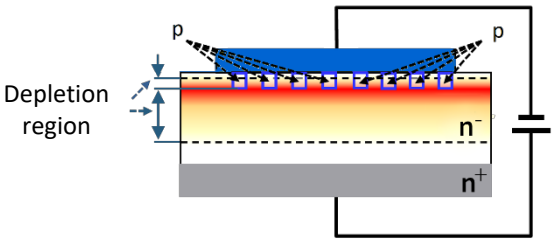
Junction Barrier Schottky (JBS) structure to reduce leakage current

In contrast to a conventional SBD where the electric field is strongest at the semiconductor-metal interface, in a JBS diode, the depletion region extends between p and n⁻ regions that are partially buried below the semiconductor surface. When the reverse bias voltage increases, p-type depletion regions punch through each other and the position of the maximum electric field moves directly under the p region. This reduces the electric field on the surface where defects may be present thereby reducing leakage current.



Maximum electric field in a conventional SBD.

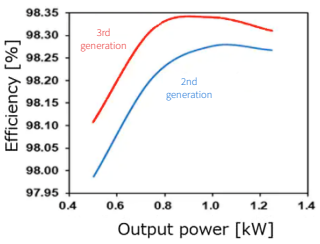
The color depth of the n- layer indicates the strength of the electric field.

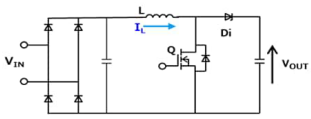


Maximum electric field in a JBS diode.

Efficiency improvement at power supply

In our boost PFC test circuit the 3rd generation SiC SBD achieved approximately 0.1 % efficiency improvement vs. the 2nd generation at the 800W output condition.





Condition
V_{IN} = 200 V AC
V_{OUT} = 400 V DC
f =65 kHz
MOSFET = TK040Z65Z
MOSFET external gate resistor= 4.7 Ω
T_a = 25 °C

SiC diode 3rd generation line-up

V_{DSS}: 650V			V_{DSS}: 1200V		
I_F (max.)	TO-220-2L	DFN 8x8	I_F (max.)	TO-247-2L	TO-247-CT
					
2A	TRS2E65H				
3A	TRS3E65H				
4A	TRS4E65H	TRS4V65H			
6A	TRS6E65H	TRS6V65H			
8A	TRS8E65H	TRS8V65H	10A	TRS10H120H	TRS10N120HB
10A	TRS10E65H	TRS10V65H	15A	TRS15H120H	TRS15N120HB
12A	TRS12E65H	TRS12V65H	20A	TRS20H120H	TRS20N120HB
			30A	TRS30H120H	TRS30N120HB
			40A	TRS40H120H	TRS40N120HB