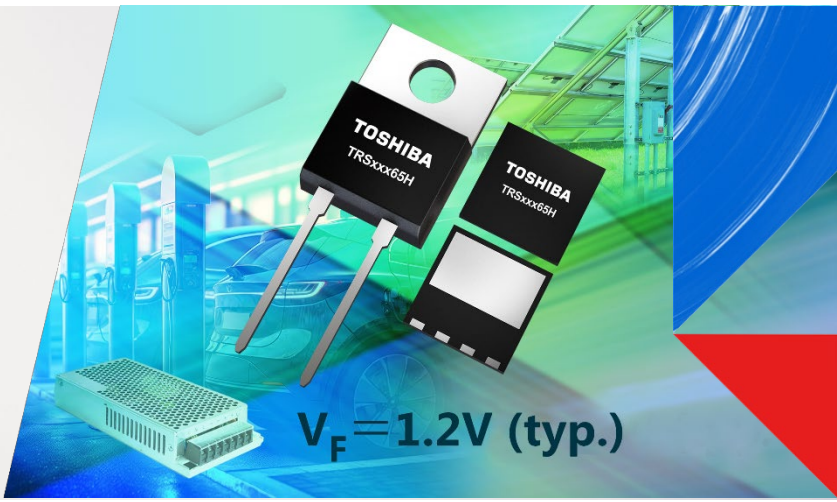
Silicon Carbide Diodes



650V 3rd Generation SiC Diodes

The TRSxxx65H Series utilizes 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, lowering the electric field at the Schottky interface and reducing leakage current to deliver enhanced efficiency. The new devices provide an industry leading low forward voltage V_F of 1.20V (typ.), which is 17% lower than the previous generation. Seven of the new devices are housed in TO-220-2L packages while the remaining five are provided in compact and flat DFN8x8 SMD packages. The new devices 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.) in 650V class
- Good trade off of V_F and Q_c
- Low reverse current I_R
- High peak forward surge current

Advantages

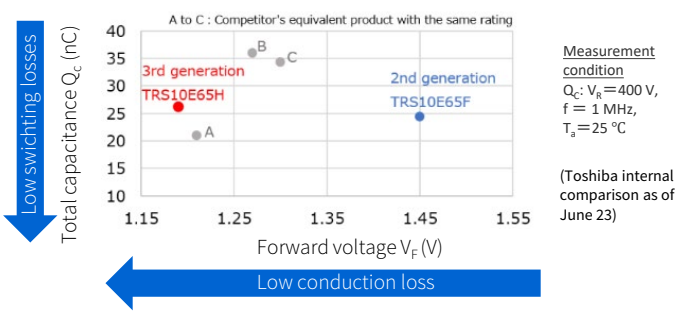
- Low forward losses
- Low diode losses
- Low reverse losses
- More design head room

Benefits

- High efficiency
- Less heat generation
- Robust product performance

V_F x Q_c Trade–off improvement

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.

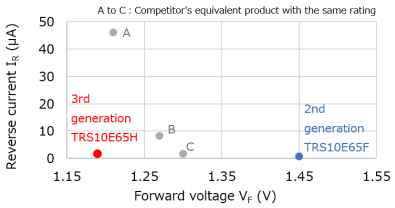


Measurement condition
Q_C: V_R=400 V, f = 1 MHz, T_a=25 °C

(Toshiba internal comparison as of June 23)

Low reverse current (leakage current)

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.

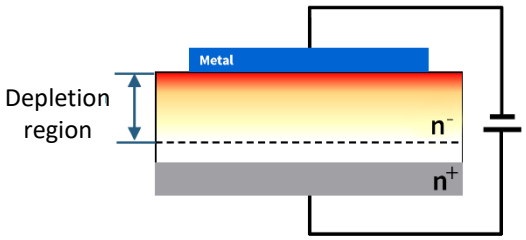


Measurement condition
I_R: V_R = 650 V, T_a = 25 °C

(Toshiba internal comparison as of June 23)

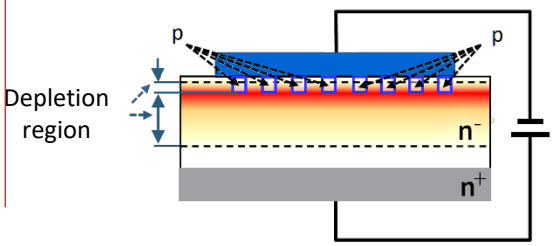
Junction Barrier Schottky (JBS) structure to reduce leakage current

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.

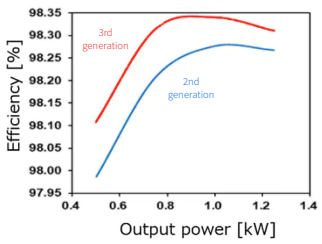
The color depth of the n- layer indicates the strength of the electric field.

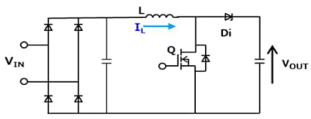


Maximum electric field in a JBS diode.

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		
I_F (max.)	TO-220-2L	DFN 8x8
		
2A	TRS2E65H	
3A	TRS3E65H	
4A	TRS4E65H	TRS4V65H
6A	TRS6E65H	TRS6V65H
10A	TRS10E65H	TRS10V65H
12A	TRS12E65H	TRS12V65H