600/650V Silicon Carbide thinQ!™ Diodes Selection Guide

Your way is our way: improve efficiency and solution costs

thinQ!™ Silicon Carbide Schottky diodes: more than 10 years experience into Generation 5 650V

Advantages of Silicon Carbide over Silicon devices

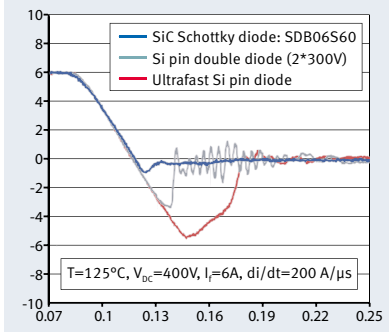
The much higher breakdown field strength and thermal conductivity of SiC allow creating SiC Schottky barrier diodes (SBD) with a much higher breakdown voltage than Silicon based devices. The extremely low switching losses with respect to bipolar Si diodes, enable reaching otherwise unattainable efficiency levels.

Key Features

- No reverse recovery charge
- Soft switching reverse recovery waveform
- Temperature independent switching behavior
- High operating temperature (T_j max 175°C)

Key Benefits

- Increased efficiency compared to Silicon Diode alternatives
- Reduced EMI compared to snappier Silicon diode reverse recovery waveform
- Highly stable switching performance
- Reduced cooling requirements, leading to benefits in either increased power density or reduced cost through smaller heatsinks and improved reliability against Silicon alternatives



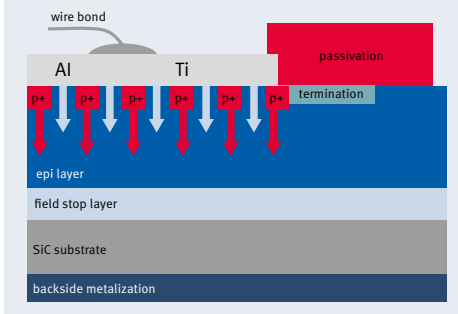
In the picture on the right: turn-off behavior of standard pin diodes, high-end Si pin double diodes and SiC SBD diodes. The area identified by the negative current and the “zero current level” is proportional to the charge stored in the device and to the switching losses. In SiC SBDs only a tiny capacitive displacement is visible.

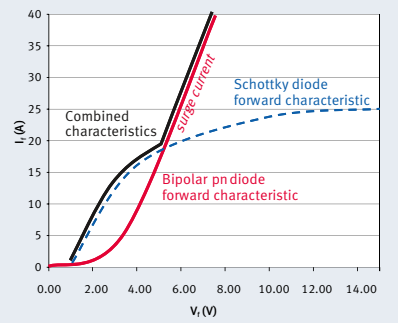
thinQ!™ Generation 2 600V

The second generation of Infineon SiC Schottky diodes has emerged over the years as the industry standard. The low V_f values characterizing this family of products, make it particularly suitable for applications requiring high load efficiency. With the Generation 2 Infineon introduced a new design concept consisting in regularly distributed p-doped areas, in conjunction with the pure Schottky ones: the so-called “merged pn-structure” (MPS).

Merged pn-structure and improved surge capability

In standard operation the device behaves like a pure SBD, but at high current levels a bipolar component is activated: the much lower voltage drop dramatically reduces the power dissipation at high current peaks and accordingly the risks for thermal runaway.



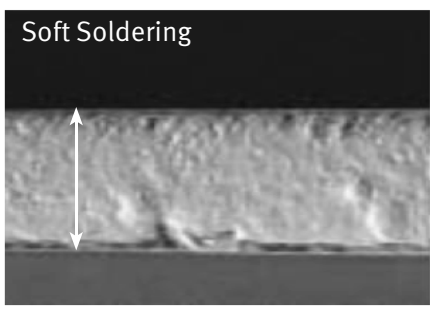


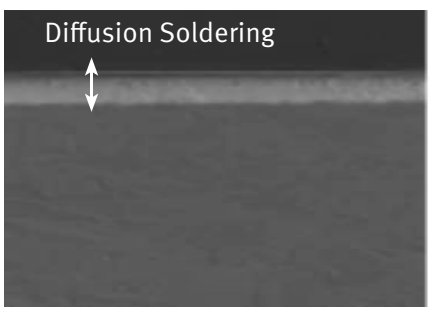
thinQ!™ Generation 3 600V

The third generation of Infineon SiC Schottky diodes features the industry’s lowest device capacitance for any given current rating, which further enhances overall system efficiency, especially at higher switching frequencies and under low load conditions. The Generation 3 is based on the same technology platform as Generation 2 with the introduction, at package level, of the so called diffusion soldering.

Diffusion soldering and improved thermal performance

Diffusion soldering is a proprietary Infineon process dramatically reducing the thickness of the solder between chip and lead frame with respect to standard soft soldering. It results into ~40% lower Rthjc per same unit Area.



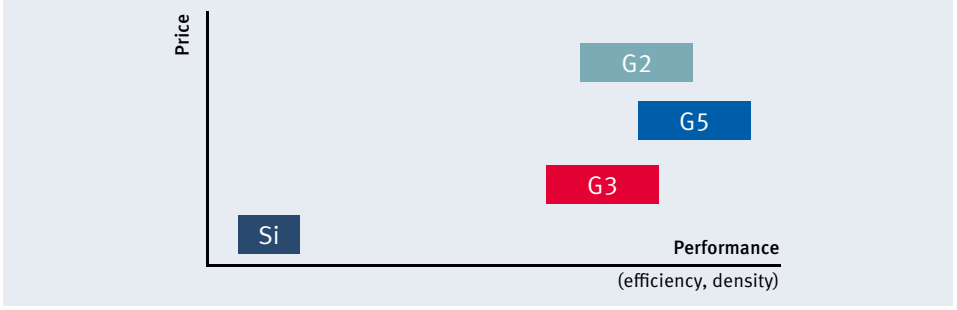


Generation 5 650V: compact design and wafer thinning technology for best price/performance level

thinQ!™ Generation 5 represents Infineon’s leading edge technology for SiC Schottky Barrier diodes. The Infineon proprietary diffusion soldering process, already introduced with G3, is now combined with a new, more compact MPS design and thin wafer technology. The result is a new family of products showing improved efficiency over all load conditions, coming from both the improved thermal characteristics and a lower figure of merit (Q_c x V_f). The new thinQ!™ Generation 5 has been designed to complement our 650V CoolMOS™ offer: this ensures meeting the most stringent application requirements in this voltage range.

Generation 5 main product characteristics

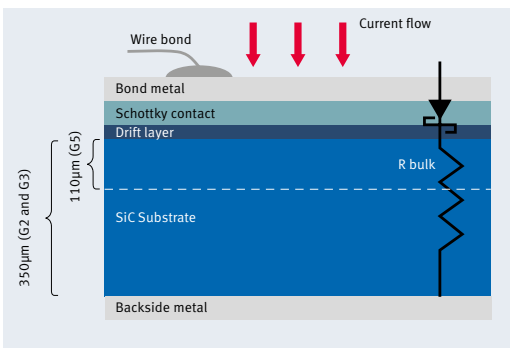
- Improved efficiency with respect to all previous generations
- Surge current capability at Gen2 level
- Increased V_{br} to 650V
- Extension of portfolio up to 40A
- New packages
- Pricing below Gen2

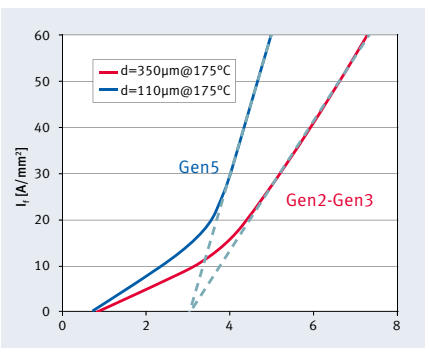


Wafer thinning

Higher surge current capability

By reducing the wafer thickness to almost 1/3, the resistive contribution of the substrate is considerably reduced and one of its most striking benefits is a consistent improvement of the surge current robustness, now at comparable level or even higher (for I_f <10A) than for Gen2, in spite of a smaller chip size.

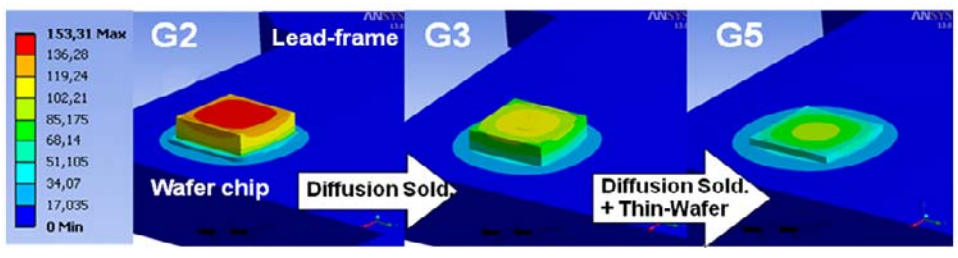




Lower thermal resistance

In combination with our proprietary diffusion soldering, the reduced thickness further contributes to decrease the overall thermal resistance in the package. The picture on the right shows the temperature increase at the junction under given forward current conditions for the same device area:

left: 350µm chip with 60µm soft solder;
middle: 350µm chip with diff. solder;
right: 110µm chip with diff. solder



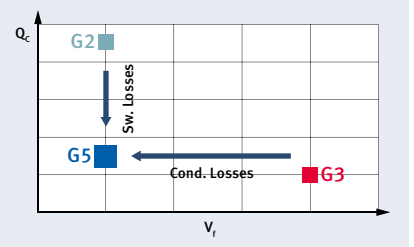
Order Number: B152-H9740-X-X-7600-DB2012-0006
Date: 07/2013

Generation 5 650V: best performance over all load conditions

Lower Figure of Merit V_f x Q_c

- Gen2 diodes have been optimized with low forward voltage (V_f)
- Gen3 is optimized with low capacitive charge (Q_c)
- Thanks to the technology advance, Gen5 can be optimized to have V_f at Gen2 level and Q_c comparable with Gen3

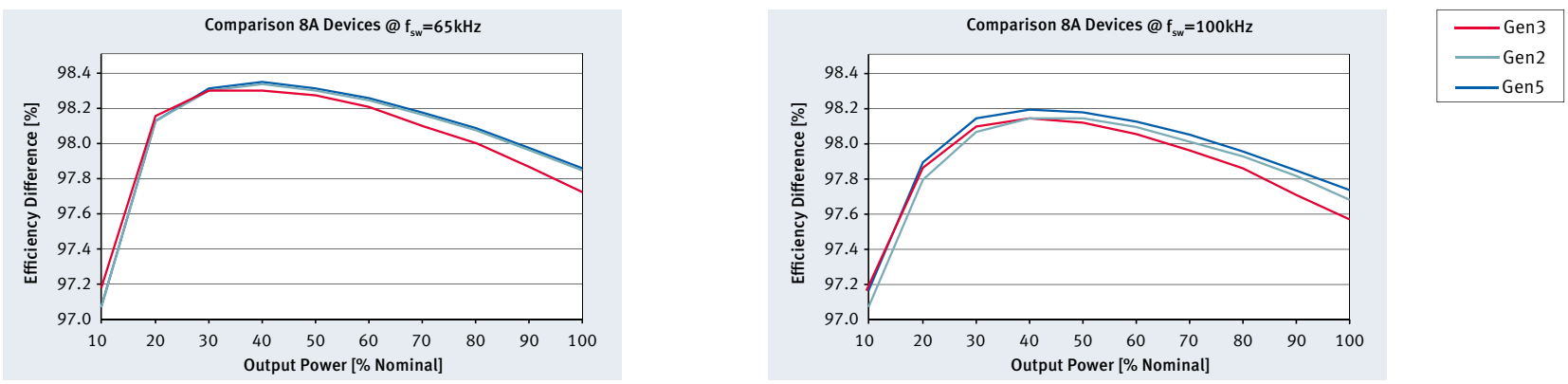
On the right picture: device tailoring in Gen5, comparison with Gen2 and Gen3 regarding of Q_c and V_f. Arrows represent the benefit in terms of device lower losses



Performance comparison

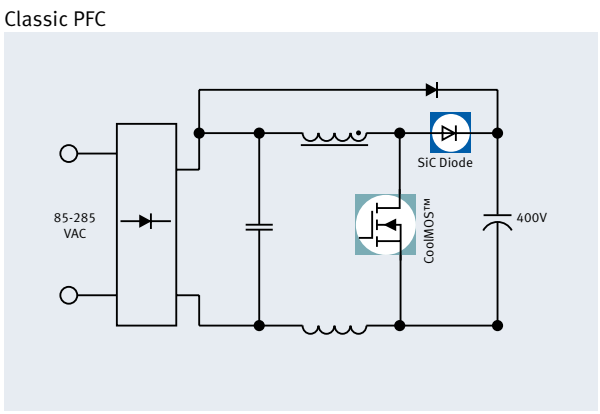
Thanks to the similar Q_c values, Gen5 efficiency is comparable to Gen3 at light load, and outperforms it at high load, because of the lower V_f. Gen2 has been optimized for high load performance, and also with respect to this family Gen5 shows clear improvements, mainly at light load; the benefits of Gen5 over Gen2 become even more evident with increasing operating frequency, because of the much lower Q_c values.

CCMode PFC, High line / V_{in}=230Vac; V_{out}=400Vdc / P_{max}=1500 W / $T_{heat\ Sink}$=60°C / Switch = IPW60R075CP

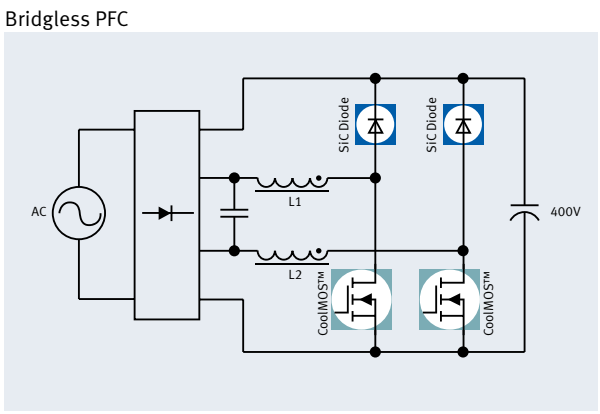


Common SiC diodes Applications and Topologies

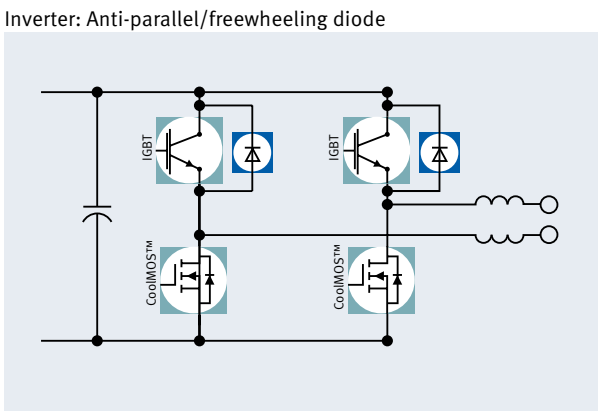
Classic PFC



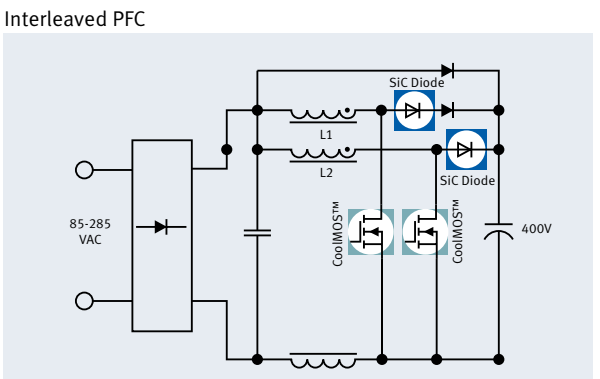
Bridgless PFC



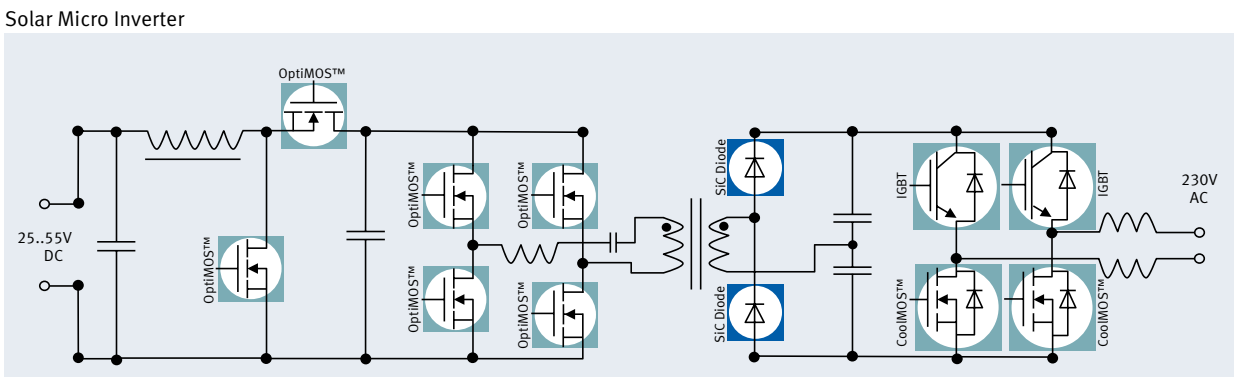
Inverter: Anti-parallel/freewheeling diode



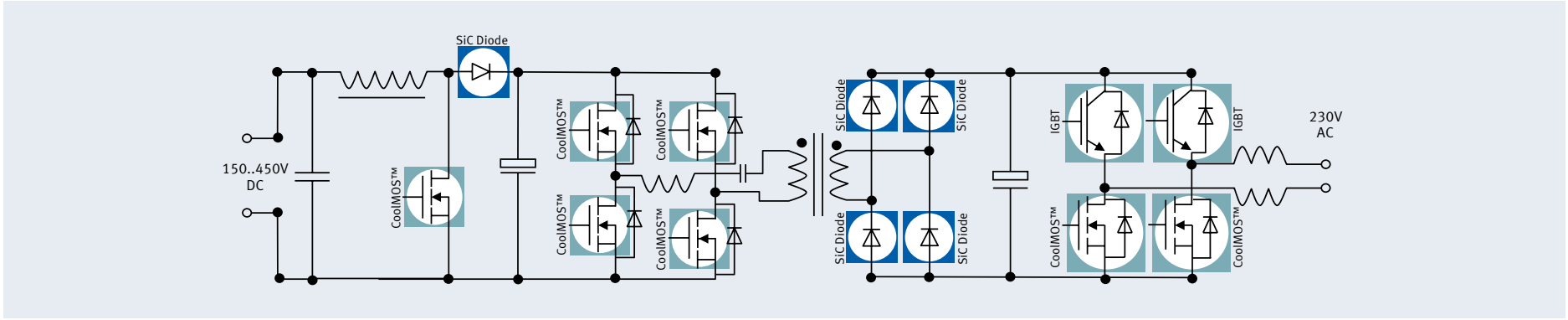
Interleaved PFC



Solar Micro Inverter



Solar string Inverter



thinQ!™ SiC diodes portfolio

Generation 2 600V

$R_{DS(on)}$ [mΩ]	TO-220 R2L	TO-220 FP	TO-247	D²PAK DML	DPAK DML	ThinPAK 8x8
2A		IDV02S60C				
3A		IDV03S60C				
4A	IDH04S60C	IDV04S60C				
5A	IDH05S60C	IDV05S60C				
6A	IDH06S60C	IDV06S60C		IDB06S60C*		
8A	IDH08S60C					
9A						
10A	IDH10S60C			IDB10S60C*		
12A	IDH12S60C					
16A	IDH16S60C					

Generation 3 600V

$R_{DS(on)}$ [mΩ]	TO-220 R2L	TO-220 FP	TO-247	D²PAK DML	DPAK DML	ThinPAK 8x8
3A	IDH03SG60C				IDD03SG60C	
4A	IDH04SG60C				IDD04SG60C	
5A	IDH05SG60C				IDD05SG60C	
6A	IDH06SG60C				IDD06SG60C	
8A	IDH08SG60C				IDD08SG60C	
9A	IDH09SG60C				IDD09SG60C	
10A	IDH10SG60C				IDD10SG60C	
12A	IDH12SG60C				IDD12SG60C	

Generation 5 650V: planned portfolio New!

$R_{DS(on)}$ [mΩ]	TO-220 R2L	TO-220 FP	TO-247 New!	D²PAK R2L New!	DPAK DML	ThinPAK 8x8 New!
2A	IDH02G65C5			IDK02G65C5		IDL02G65C5
3A	IDH03G65C5			IDK03G65C5		
4A	IDH04G65C5			IDK04G65C5		IDL04G65C5
5A	IDH05G65C5			IDK05G65C5		
6A	IDH06G65C5			IDK06G65C5		IDL06G65C5
8A	IDH08G65C5			IDK08G65C5		IDL08G65C5
9A	IDH09G65C5			IDK09G65C5		
10A	IDH10G65C5		IDW10G65C5	IDK10G65C5		IDL10G65C5
12A	IDH12G65C5		IDW12G65C5	IDK12G65C5		IDL12G65C5
16A	IDH16G65C5		IDW16G65C5			
20A	IDH20G65C5		IDW20G65C5			
30A			IDW30G65C5			
40A			IDW40G65C5			

*these parts will be discontinued once Gen5 D²PAK is released