1200 V CoolSiC™ Schottky Diode Generation 5:

New level of system efficiency and reliability

May 2016

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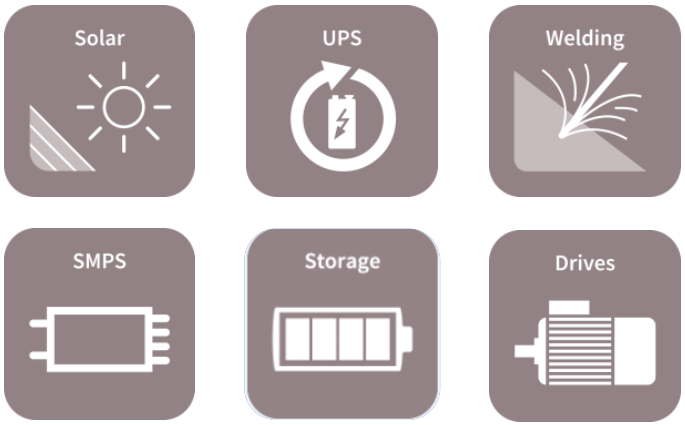
Application areas

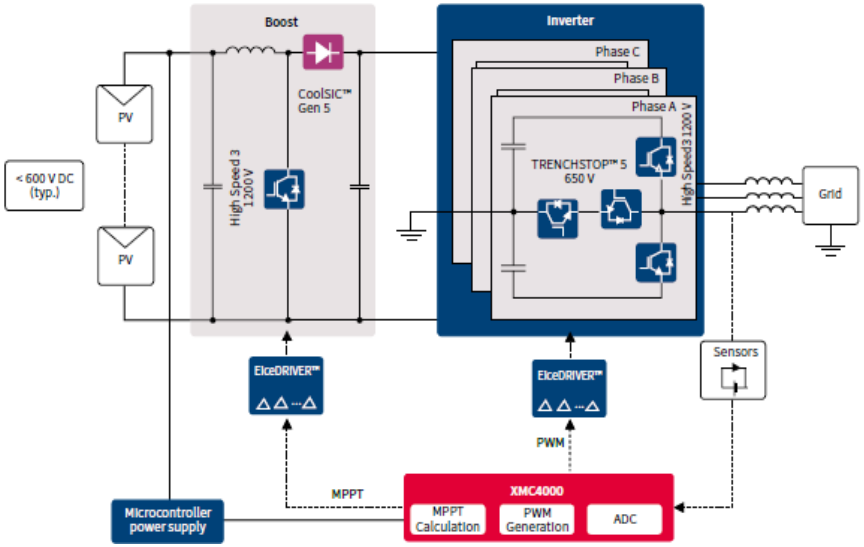
Silicon based solution

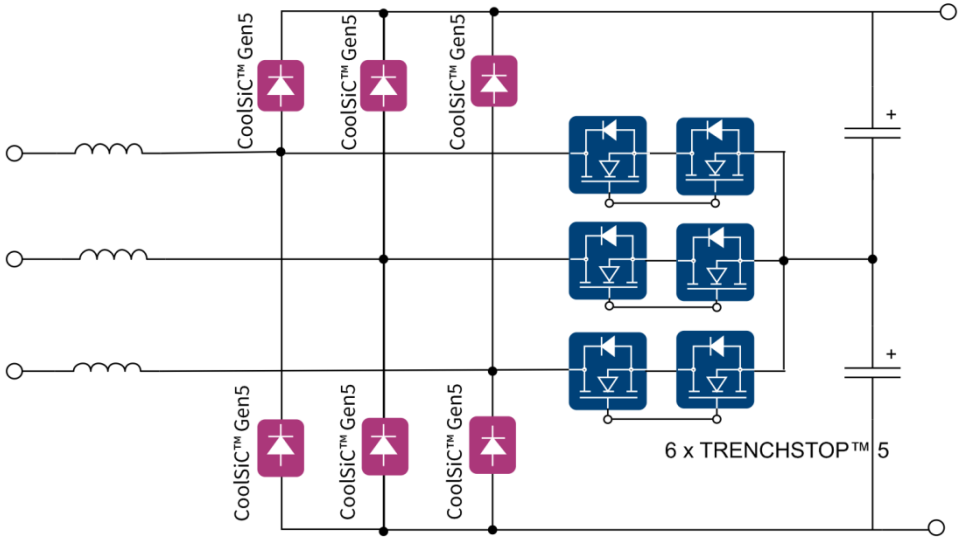


Design in a new level of efficiency & reliability?

Enabled by SiC Schottky diodes

Application examples





String inverter 3-phase, 1 kW – 30 kW: **Boost stage**

SiC Diode: 1200 V G5 TO-220/TO-247
IGBT: HighSpeed 3 1200V TO-247
IGBT Driver: 1ED020I12-F2, 2ED020I12-F2
µController: XMC4000

UPS: **Vienna Rectifier**

SiC Diode: 1200 V G5 TO-220 / TO-247
IGBT: TRENCHSTOP™ 5 650 V TO-247

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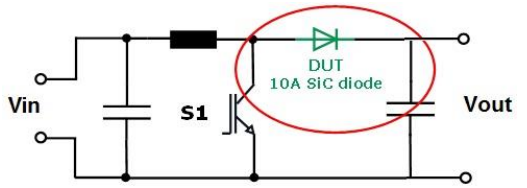
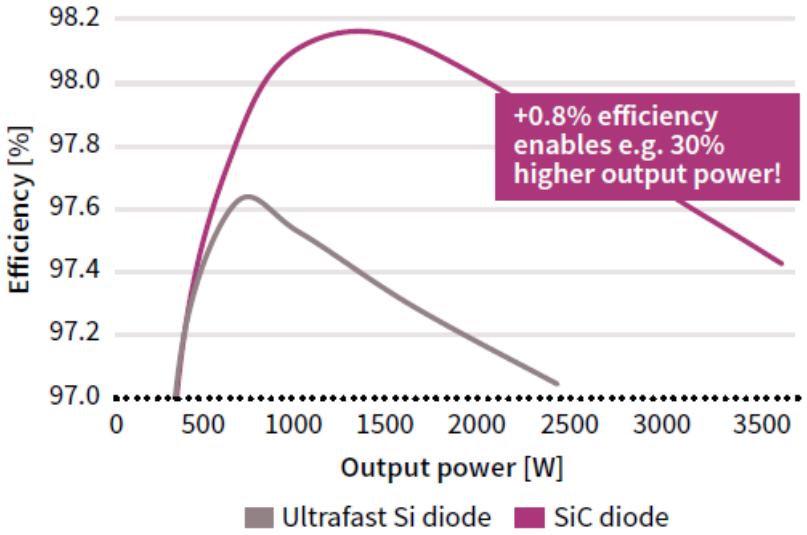
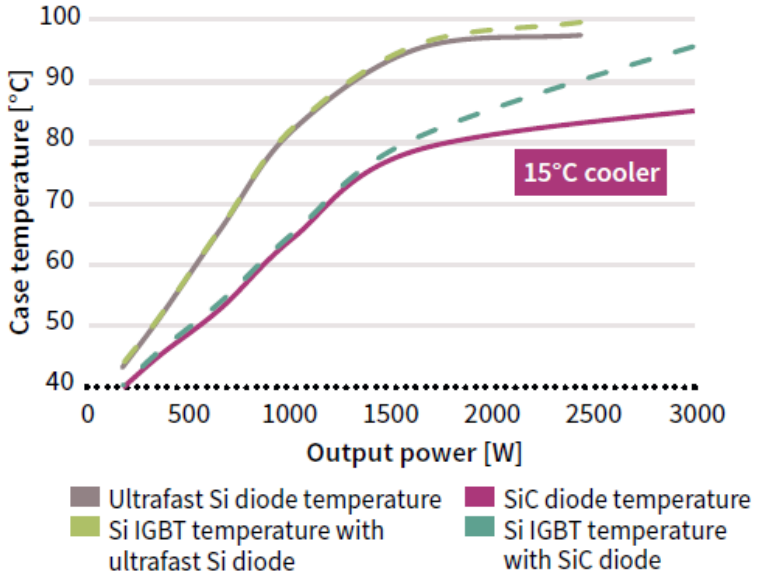
No more pain with dynamic losses

Example:
1200 V Si IGBT + SiC diode in a boost stage topology
V_{in}= 400 V, V_{out}= 800 V, f_{sw}=20 kHz



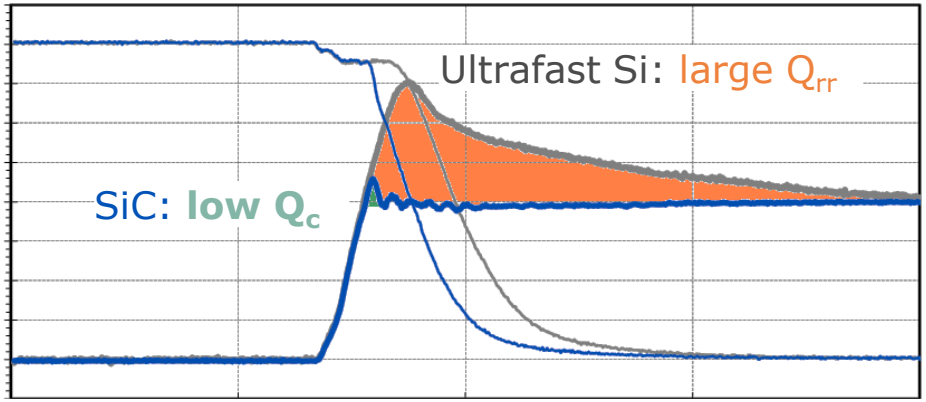




SiC diode compared to Si diode, has …

… higher system efficiency,
… lower device thermals, for
… increased power density and reliability!

SiC diode benefit – Less leads to more



Features

- No reverse recovery charge
- No forward recovery
- Purely capacitive switching

Technical benefits

- **E_{rec} close to zero**
- **40-50% reduction in IGBT turn-on loss**
- No voltage overshoots
- Switching losses independent from load current, switching speed and temperature

Customer benefits

- **20-30% higher output power in same form factor**
- Reduced EMI
- No need for snubber circuitry, reduced parts count
- High system reliability

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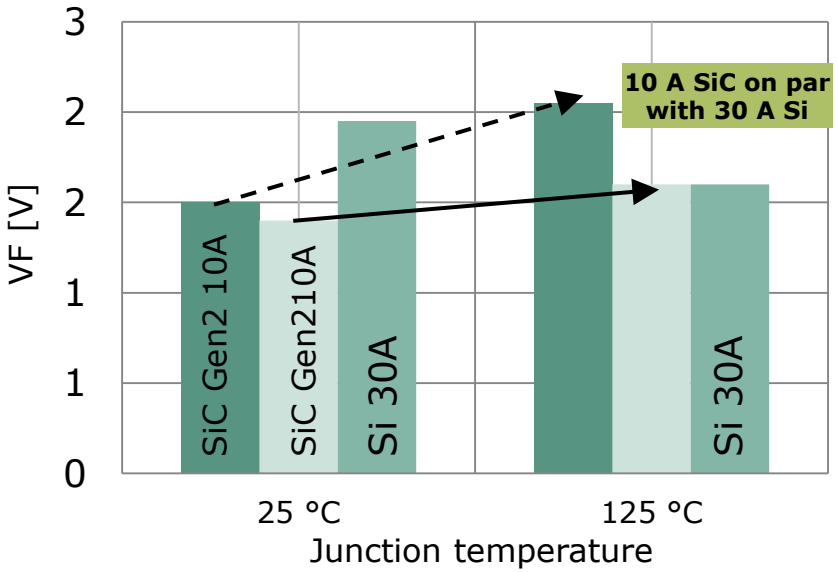
Major improvement in static losses while maintaining virtually zero reverse recovery charge

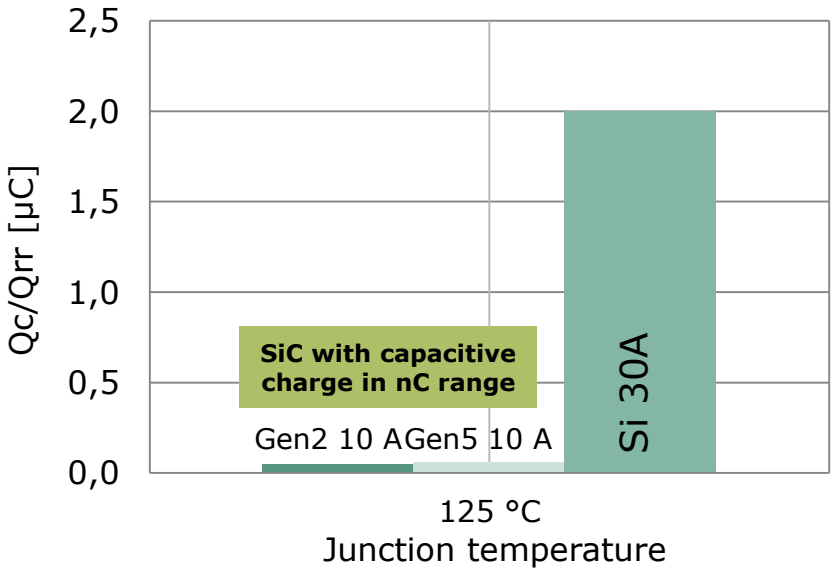
1200 V CoolSiC™ Schottky Diode Generation 5

1. Reduction of V_F and its temperature dependency for low static losses over entire load range

Forward voltage, V_F, of SiC and ultrafast Si diodes



Reverse recovery charge, Q_c/Q_{rr}, of SiC and ultrafast Si diodes



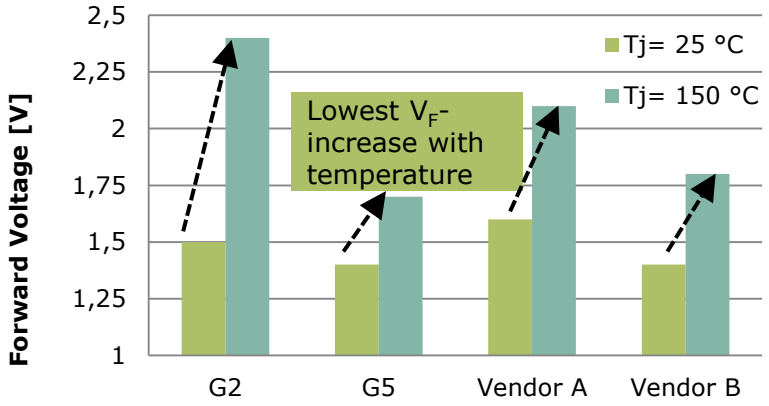
* Based on datasheet values

Generation 5 is the performance-leading SiC diode

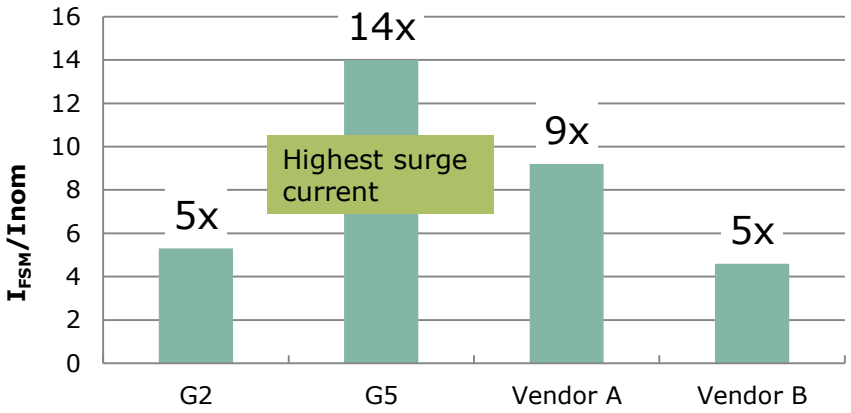
1200 V CoolSiC™ Schottky Diode Generation 5

2. Thermal performance improvement
3. Extended surge current capability for improved reliability

V_F at rated current SiC diodes in TO-247



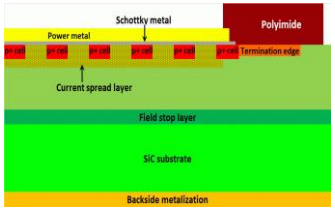
Surge current SiC diodes in TO-247



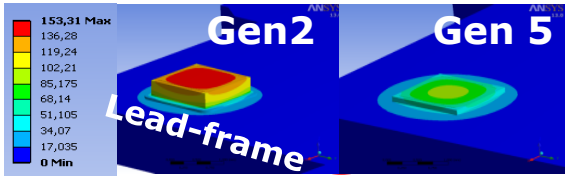
* Based on datasheet values

Consistent innovation made the way for Generation 5

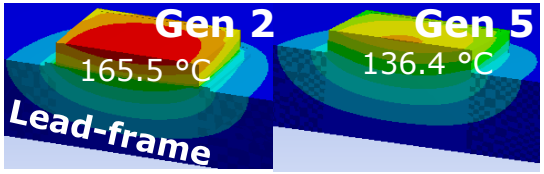
Merged Pn Schottly (MPS) design



Thin wafer technology



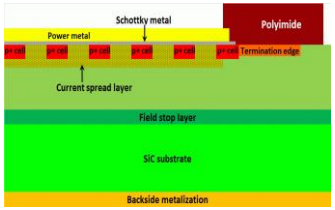
Diffusion bonding



Improved performance and chip shrink

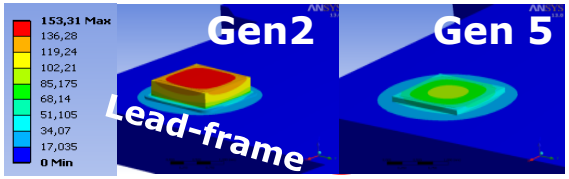
Consistent innovation made the way for Generation 5

Merged Pn Schottly (MPS) design



- 40% lower resistive losses than Generation2 having pure Schottky design
  → **reduced V_F and higher current density**
  → **low temperature dependency on VF**
- **High surge current capability**

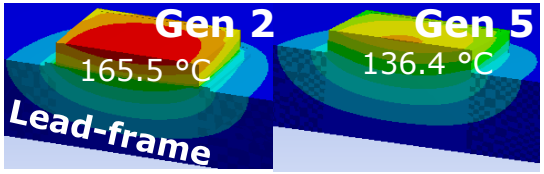
Thin wafer technology



- Smaller differential resistance per chip area
- Better heat spread between junction and case

→ **higher current density operation**

Diffusion bonding (TO-220, DPAK)



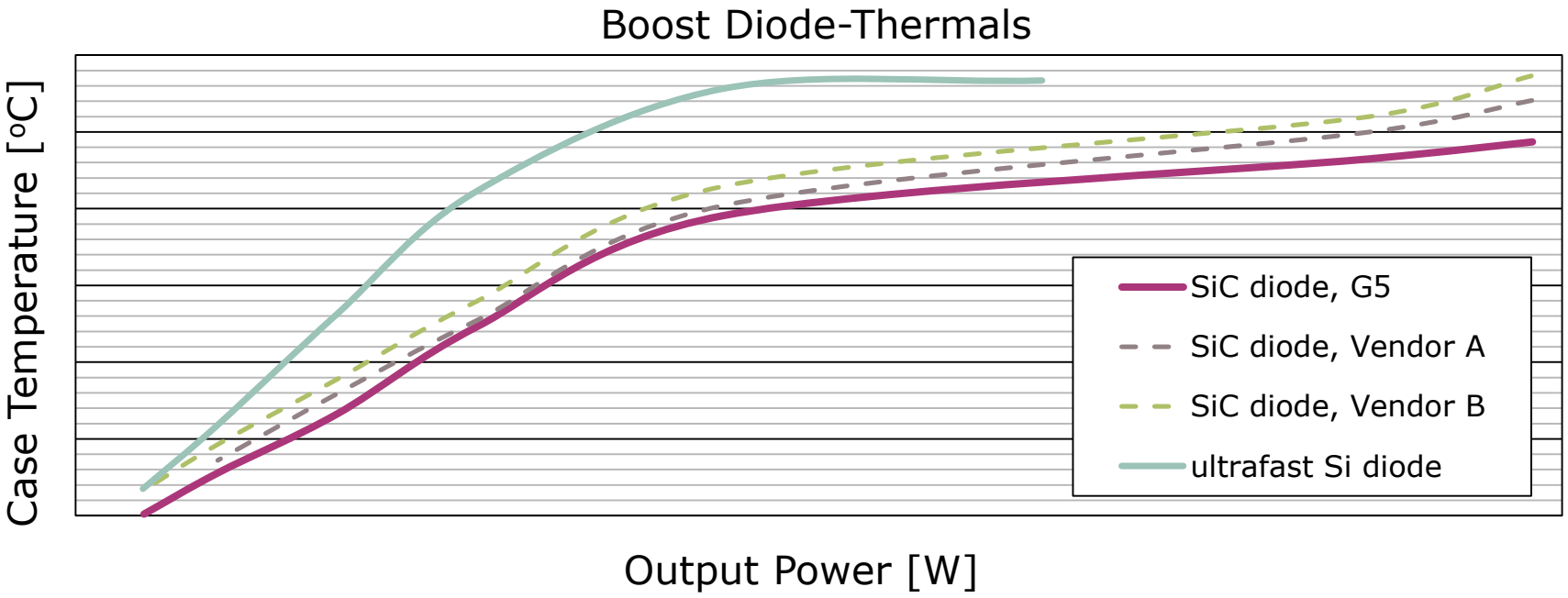
- Smaller thermal resistance

→ **higher current density operation**

The result: lowest losses and lowest case temperatures

Example:

1200 V HighSpeed3 Si IGBT with SiC diodes vs. Si diode in a boost stage topology, V_{in}= 400 V, V_{out}= 800 V, f_{sw}=20 kHz



✓ Best optimization potential for system improvements
e.g. increasing output power

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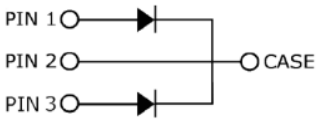
1200 V CoolSiC™ Schottky Diode Generation 5: up to 40 A in TO-247, 20 A in TO-220 and 10 A in DPAK

I_F	TO-252-2 (DPAK)	TO-220-2	TO-247-3
2 A	IDM02G120C5	IDH02G120C5	
5 A	IDM05G120C5	IDH05G120C5	
8 A	IDM08G120C5	IDH08G120C5	
10 A	IDM10G120C5	IDH10G120C5	IDW10G120C5B*
15-16 A		IDH16G120C5	IDW15G120C5B*
20 A		IDH20G120C5	IDW20G120C5B*
30 A			IDW30G120C5B*
40 A			IDW40G120C5B*

*) "B" refers to common-cathode configuration:



Focus applications across portfolio

<table>
<tr><th>I_F</th><th>TO-252-2
(DPAK)</th><th>TO-220-2</th><th>TO-247-3</th></tr>
<tr><td>2 A</td><td rowspan="4">Micro Inverter[1]
SMPS</td><td rowspan="3">Micro Inverter[1]
SMPS, UPS</td><td></td></tr>
<tr><td>5 A</td><td></td></tr>
<tr><td>8 A</td><td></td></tr>
<tr><td>10 A</td><td rowspan="4">UPS</td><td rowspan="7">String Inverter and UPS</td></tr>
<tr><td>15-16 A</td><td></td></tr>
<tr><td>20 A</td><td></td></tr>
<tr><td>30 A</td><td></td></tr>
<tr><td>40 A</td><td></td></tr>
</table>

[1]Rectification in secondary side

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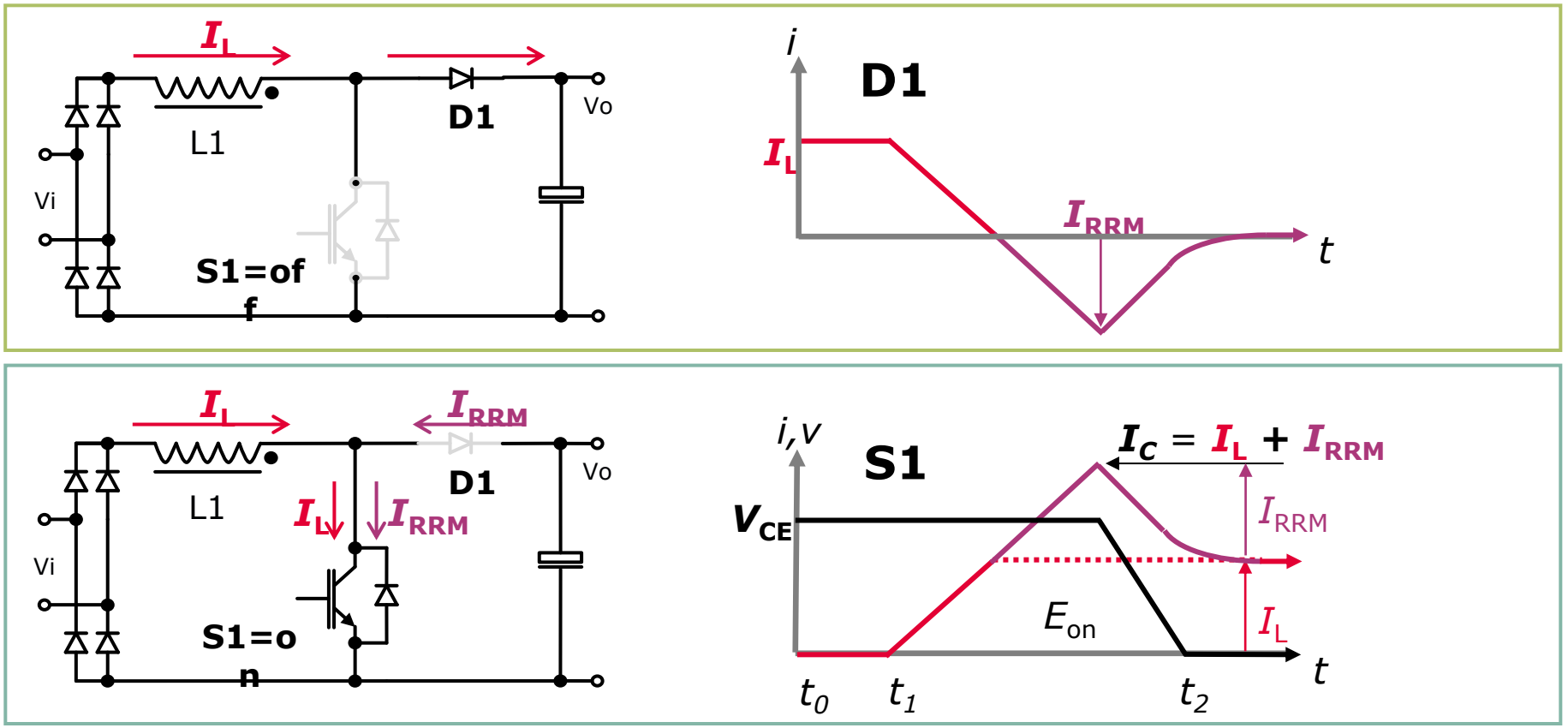
Great system impact thanks to zero diode turn-off loss and reduced IGBT turn-on



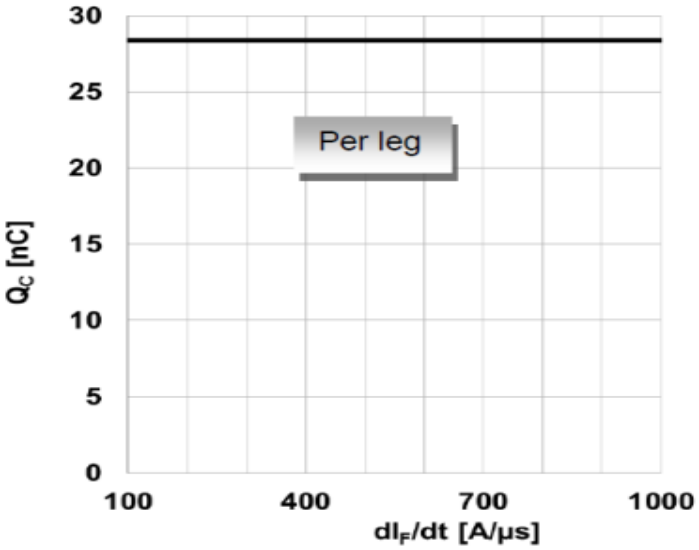
Up to 40-50% reduction in IGBT turn-on loss

- Decreased I_{RRM} means decreased S1 (IGBT) turn-on losses
- $E_{on} = \int_{t1}^{t2} V_O * \boldsymbol{I_C} * dt$

Switching Losses, Psw, in SiC and Si diodes

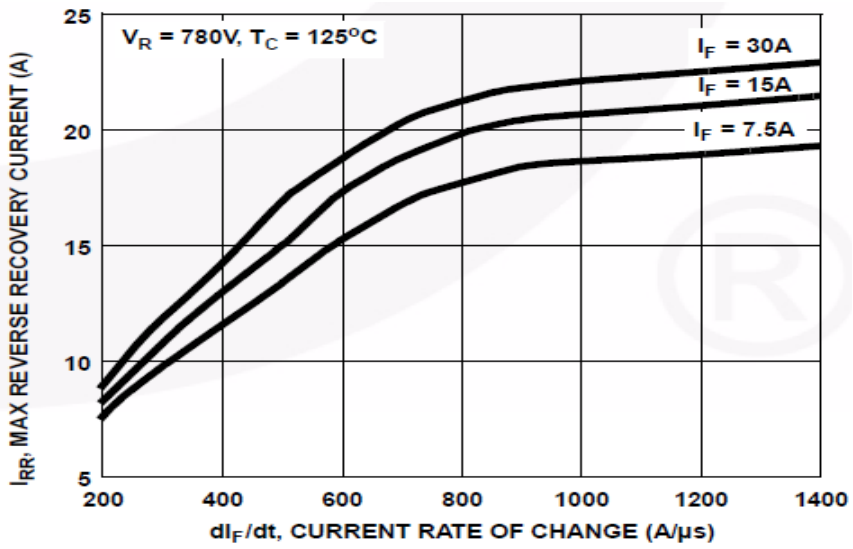
SiC Diode

$$P_{sw} = 0.17 * V_o * f * \mathbf{Q_C}$$



Si Diode

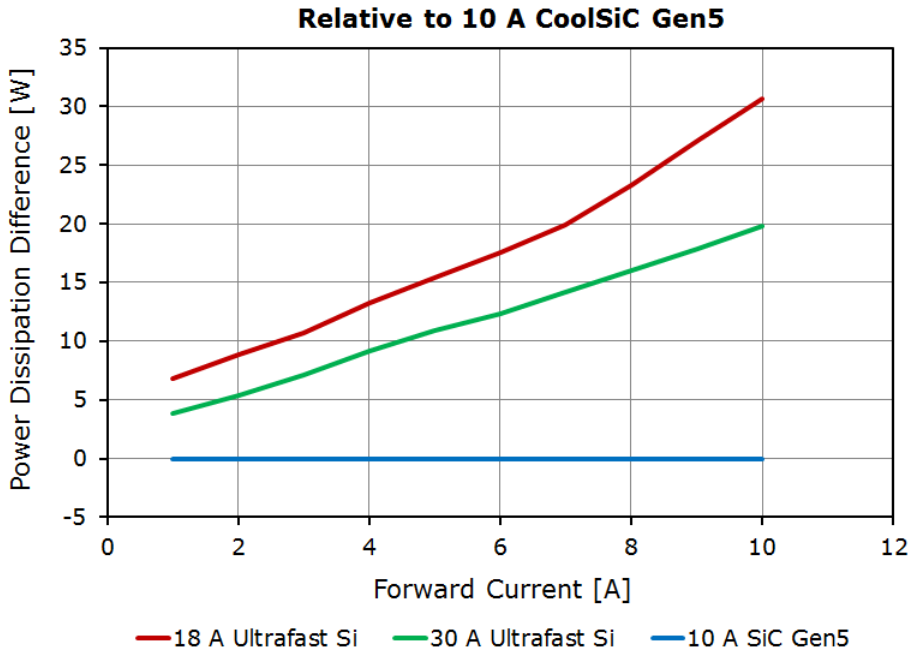
$$P_{sw} = 0.17 * V_o * f * \mathbf{I_{RRM}} * \mathbf{t_B}$$

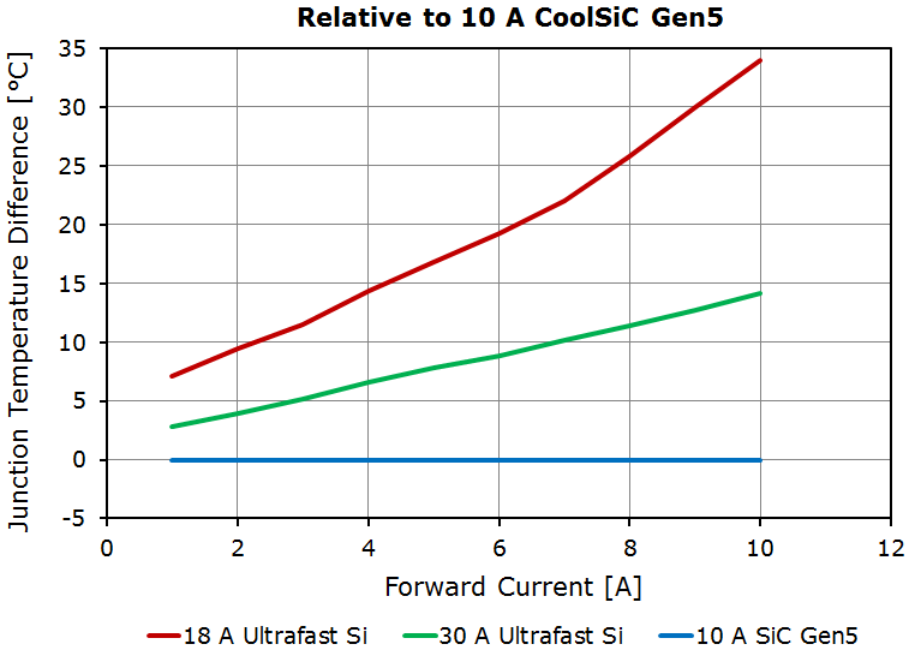


SiC switching loss is very low compared to Si:

- Si shows higher P_{sw} than SiC due to I_{RRM}
- I_{RRM} and t_B values depends on diode forward current, di_f/dt and diode junction temperature

30 A rated Si diode can be exchanged to even a 10 A CoolSiC™ Generation 5 SiC diode!





30 A Si dissipates more power than a 10 A SiC

- 18 A Si have 8.8 W additional power dissipation compared to 10 A SiC @ 2 A I_F
- 18 A Si have 9.4°C higher junction temp. compared to 10 A SiC @ 2 A I_F

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Summary

- By using SiC diodes, designers for solar inverters, UPS, motor drives and other industrial applications can design in a new level of system efficiency, higher power density and reliability compared with Si based solution

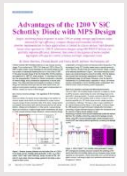
- 1200 V CoolSiC™ Schottky diode generation 5 supports this by low-loss turn-off, low static losses and increased surge current capability

Support materials

Collaterals and brochures


- Selection Guides
- Product Briefs
- Application Brochures
- Presentations
- Press Releases, Ads

Technical material




- Application Notes
- Technical Articles
- Simulation Models
- Datasheets

Support and tools

- PCB Design Data
- Simulation Models

Videos

- Technical Videos
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