SiC MOSFET with high temperature stability

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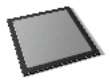
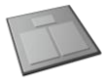
Bodo's Wide Bandgap Event 2024

Making WBG Designs Happen

SiC

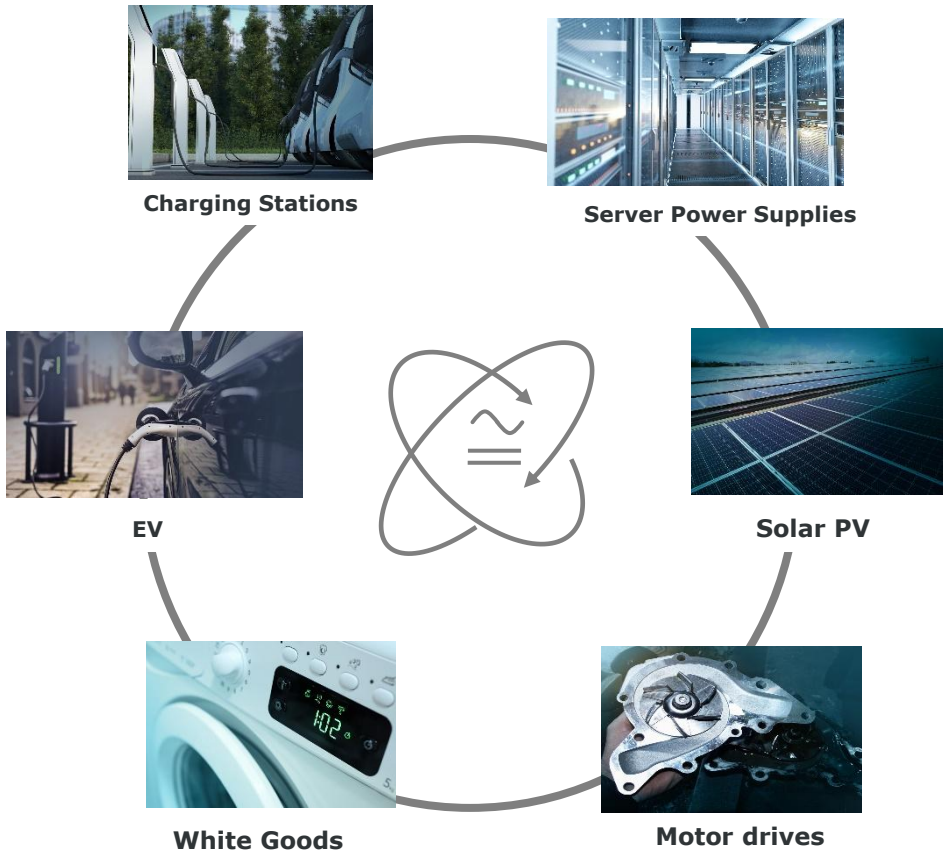
Nexperia is broadening its SiC technology roadmap
Strong portfolio expansion by packages and voltage classes

		650 V	1200 V
SiC Schottky Diodes	 Discretes	Released/ Mass production	Coming soon
	 Bare die	Released/ Mass production	Coming soon
SiC MOSFETs	 Discretes	Not planned	Coming soon
	 Bare die	Not planned	On roadmap
	 Top Side Cooling	Not planned	Coming soon

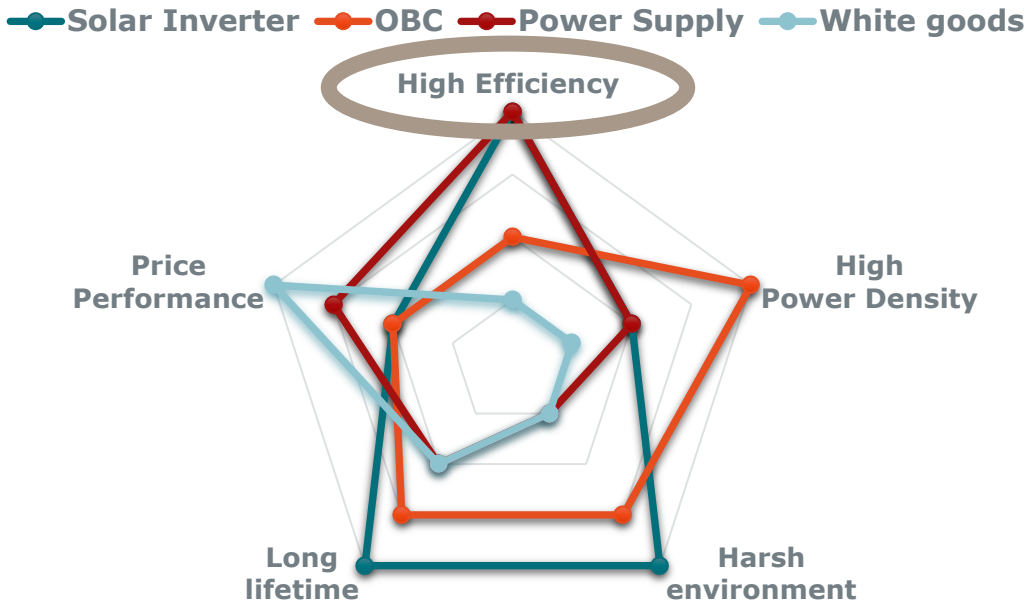
Released/ Mass production · Coming soon · On roadmap · Not planned

The customers' very individual application requirements

Power semiconductors beyond 600V



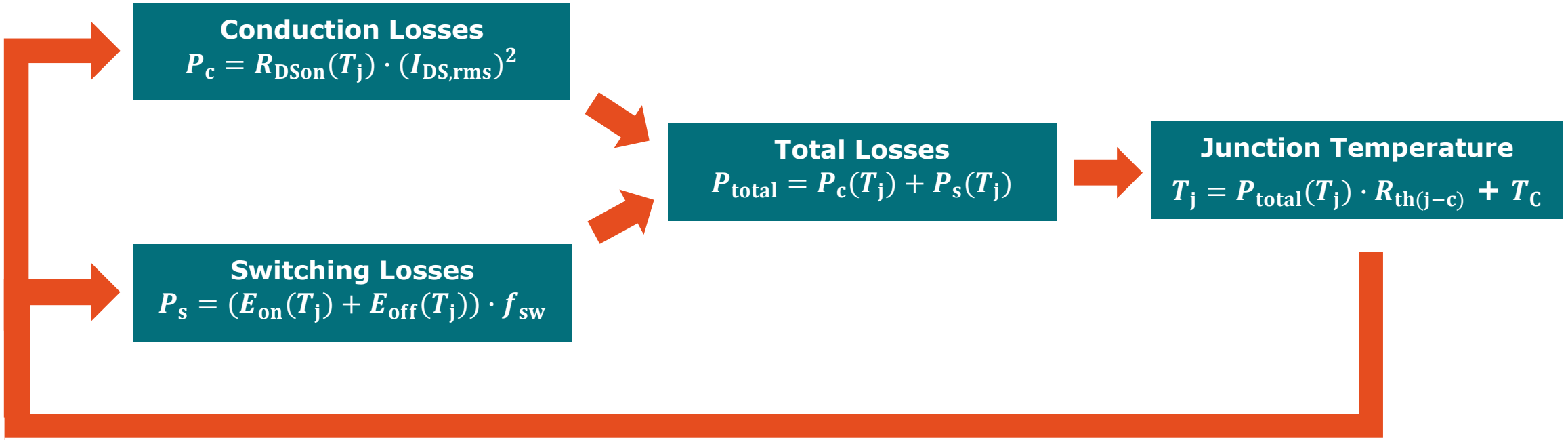
Technical customer requirements impacting semiconductor choice



Other strategic factors impacting semiconductor choice

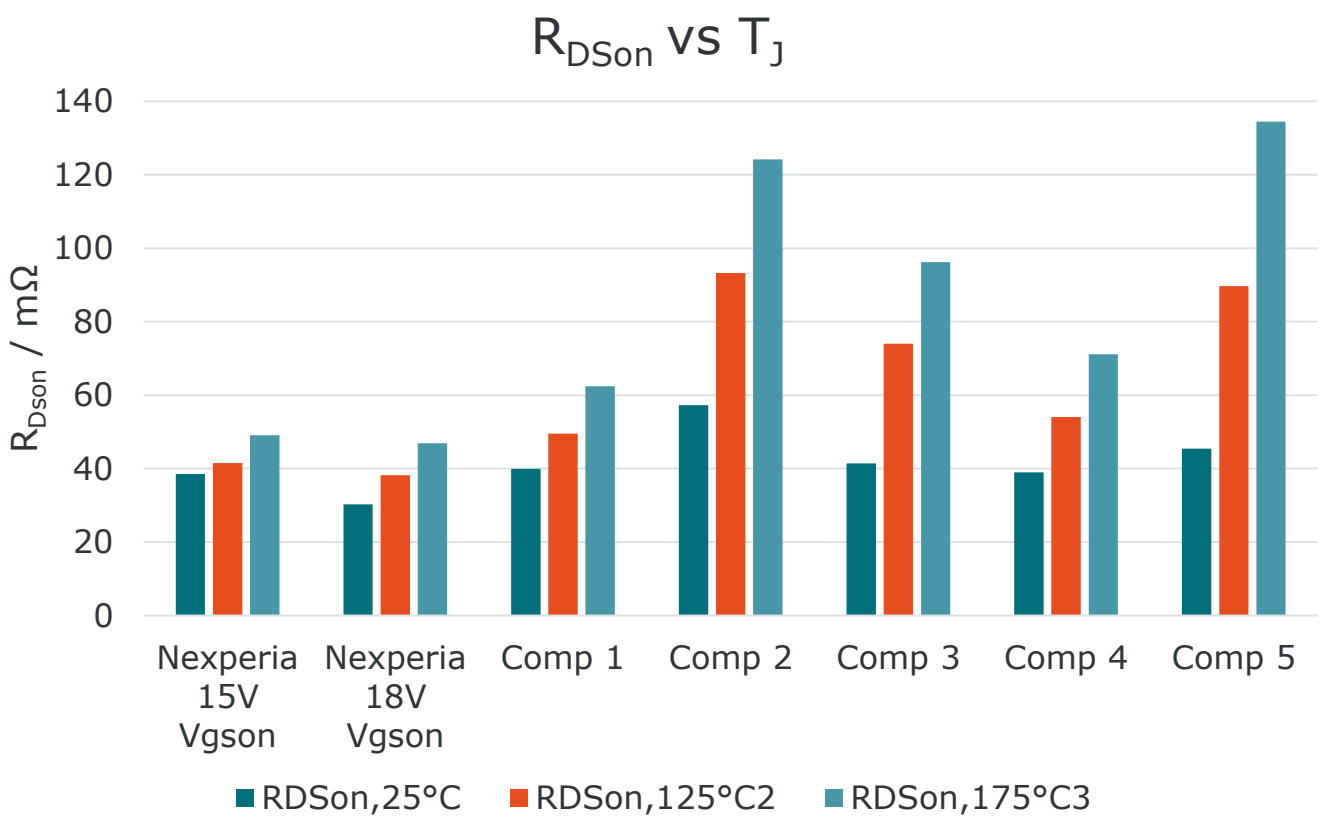
- Assembly & package strategy
- Purchasing strategy
- Second & multi-sourcing & supply security strategy
- Design-in efforts vs performance benefits of new products
- Quality & Customer support

Total power loss circle



Key Question: P_c vs P_s and how R_{DSon} stability can be beneficial for converter efficiency?

R_{DSon} performance: Comparison under same conditions



Note: RDSon **measured** at IDS=40A and recommended v_{gson}

Similarly rated SiC MOSFETs in the market show different Rdson behavior.

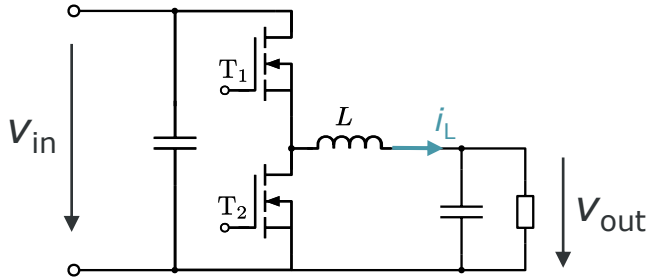
Conduction loss distribution varies in converters at different load conditions

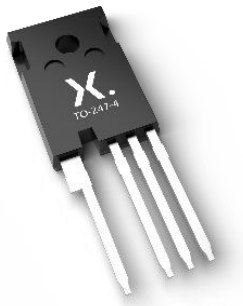
R_{DSon} conditions are not standardized

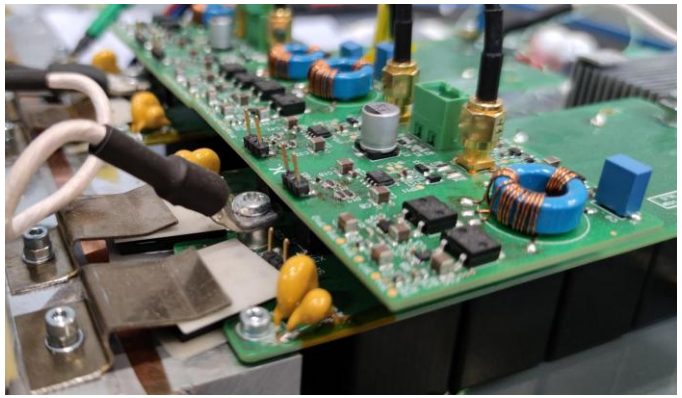
Carefully look at:

- i_D
- v_{GSon}
- T_j
- dR_{DSon}/dT_j (temperature dependency)

Hard- and Soft-Switching in Half-bridge configuration







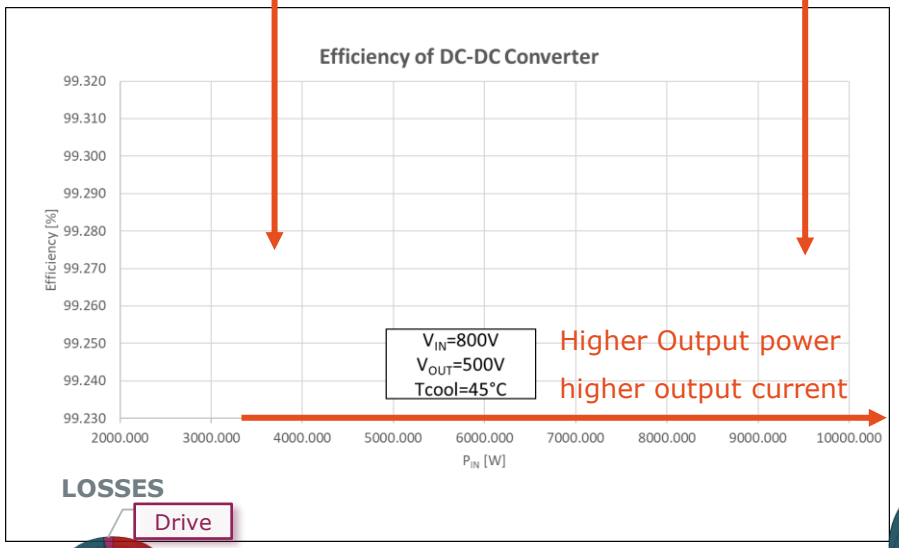
Lower loss

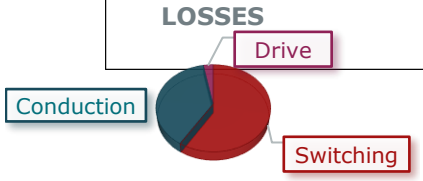
Lower junction temperature

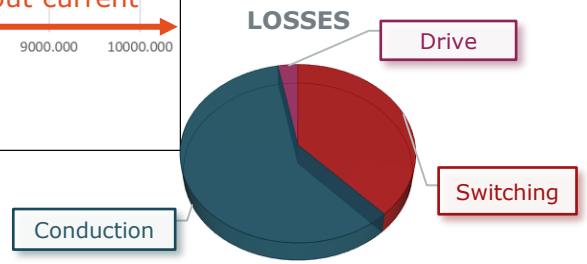
Higher loss

Higher junction temperature

Dictates Heat sink





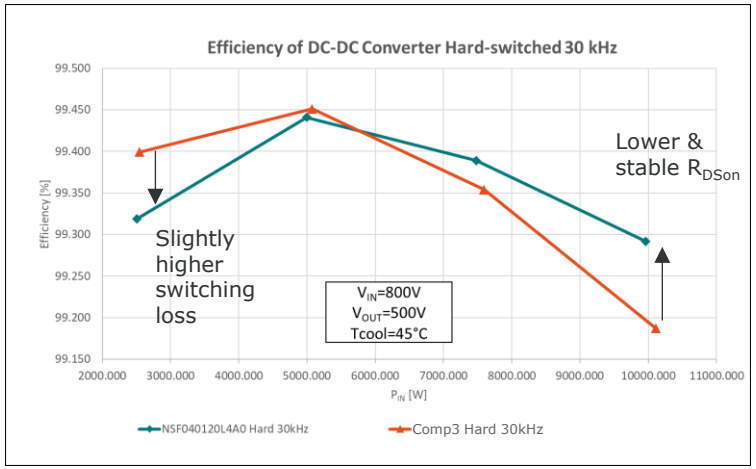


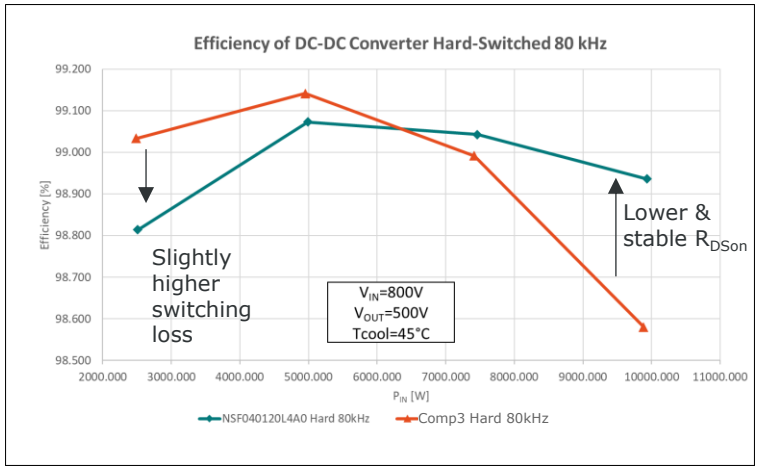
Test Conditions:

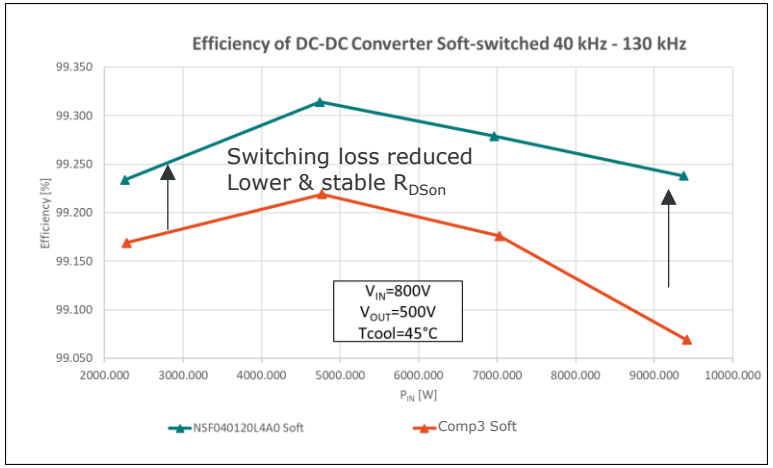
- T1 and T2 controlled by complementary PWM signals
- Water cooling and $T_{coolant}$ = 45°C
- Power Analyzer Yokogawa WT5000
- Thermal Interface Material (TIM): Aluminium Nitride
- Power Inductor
  - For Hard Switching: 970µH
  - For Soft Switching: 110µH

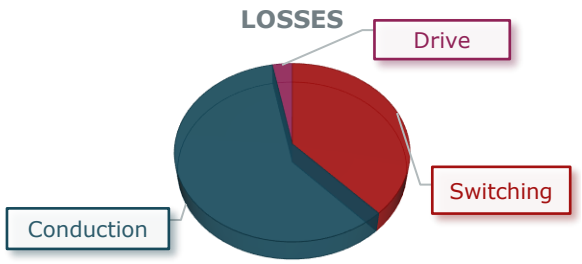
Measurement results: impact of RDSon stability on the efficiency

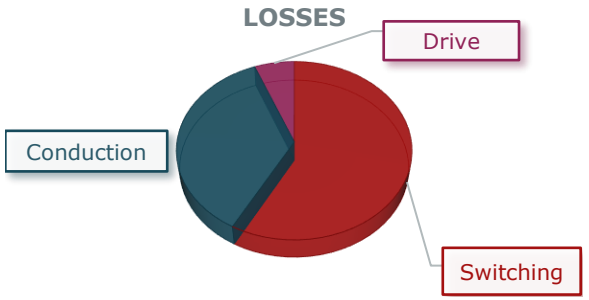
- NSF040120L4A0 : Planar MOSFET
- Competitor 3 : Trench MOSFET

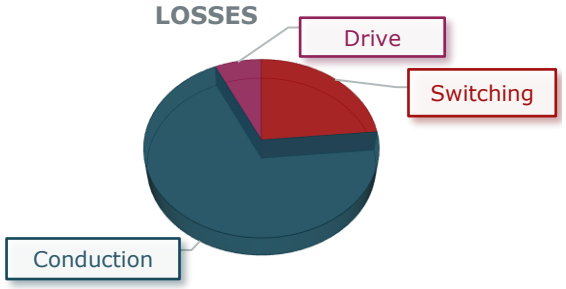










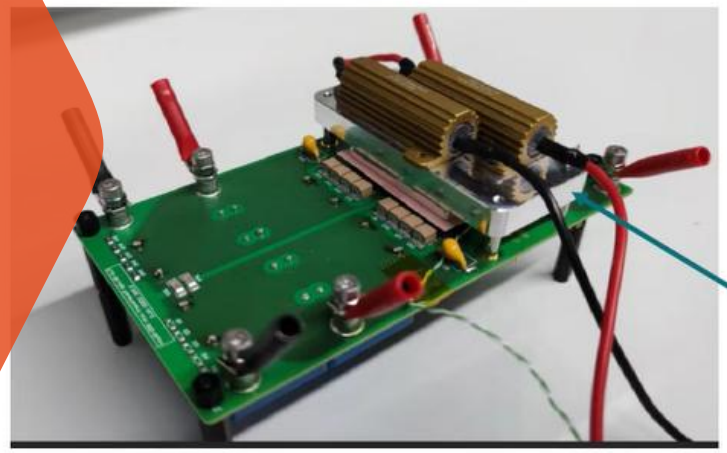


Conclusions

- RDSon is not a standardized in datasheet
- SiC MOSFETs will operate at high temperature → datasheet values at 25°C are less relevant
  - Nexperia offers SiC MOSFETs with RDSon temperature stability
- In the case of hard switching: at high power, Tj increases, affecting the efficiency of the converter → Nexperia devices show improved efficiency due to RDSon stability
- In the case of soft switching: conduction losses dominate over a wide power range and RDSon temperature stability becomes essential for high efficiency converters.

The X.PAK Board – Key features 8-in-1 Board !

Thank you for your attention!



Key Features:

- 4 DUTs in XPAK assembled
- Enhanced PCB design to minimize loop inductance
- Testing Single or Paralleled Devices
- SMD Resistor Shunt
- Junction Temperature 25°C-175°C

Gate Driver Board

Adapter Board for Gate Resistance

Adapter Board for Device Paralleling

Heater for Junction Temperature Variation