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STPOWER SiC MOSFET offer for Car Electrification

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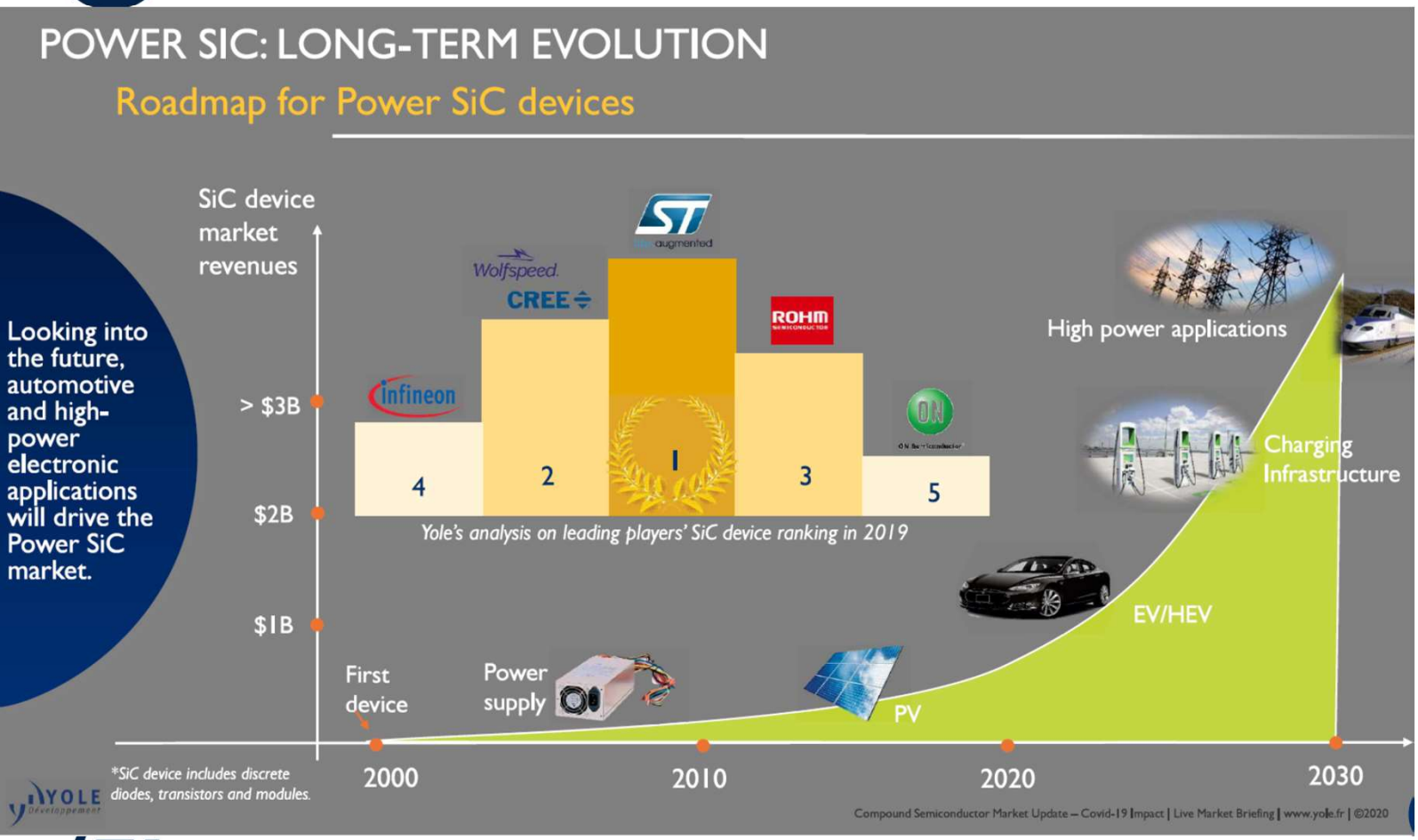
Thèmes

1. Rôle de ST dans l'électrification de la voiture
2. Marché du SiC envers les produits de puissance en silicium
3. Voiture électrique: un environnement idéale pour le SiC
4. Avantages du SiC dans un onduleur de traction
5. Feuille de route de technologie
6. Stratégie manufacturière du SiC
7. Offre complète de technologies
8. Innovation packaging
9. Conclusions

ST in car electrification

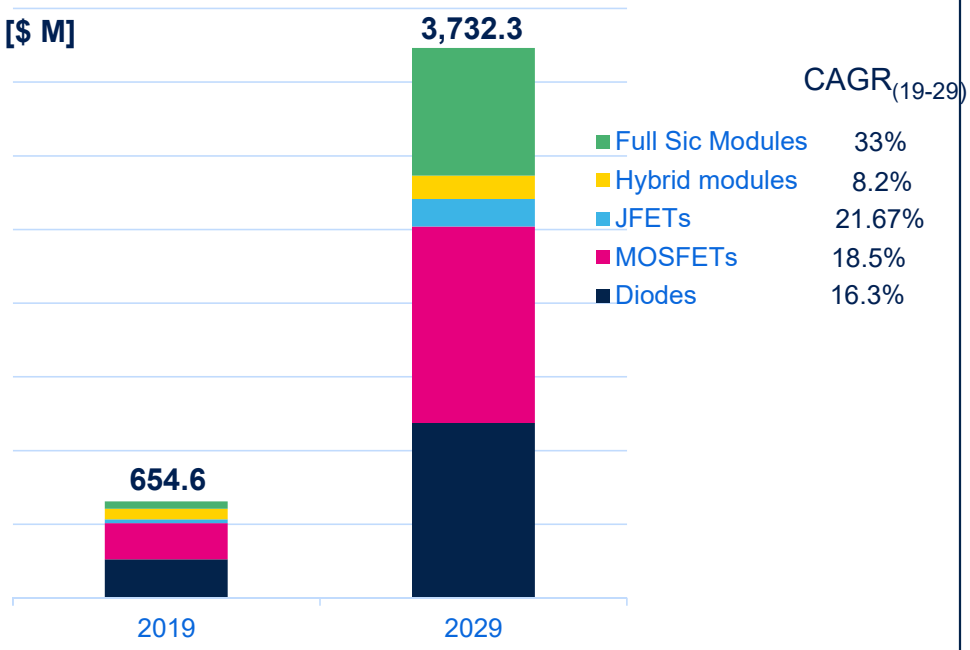


i. First place in SiC devices
ii. Second biggest player in power for Automotive (*)
iii. Third position in power discrete products and modules (*)

(*) IHS Markit 2020

Silicon Carbide - market outlook

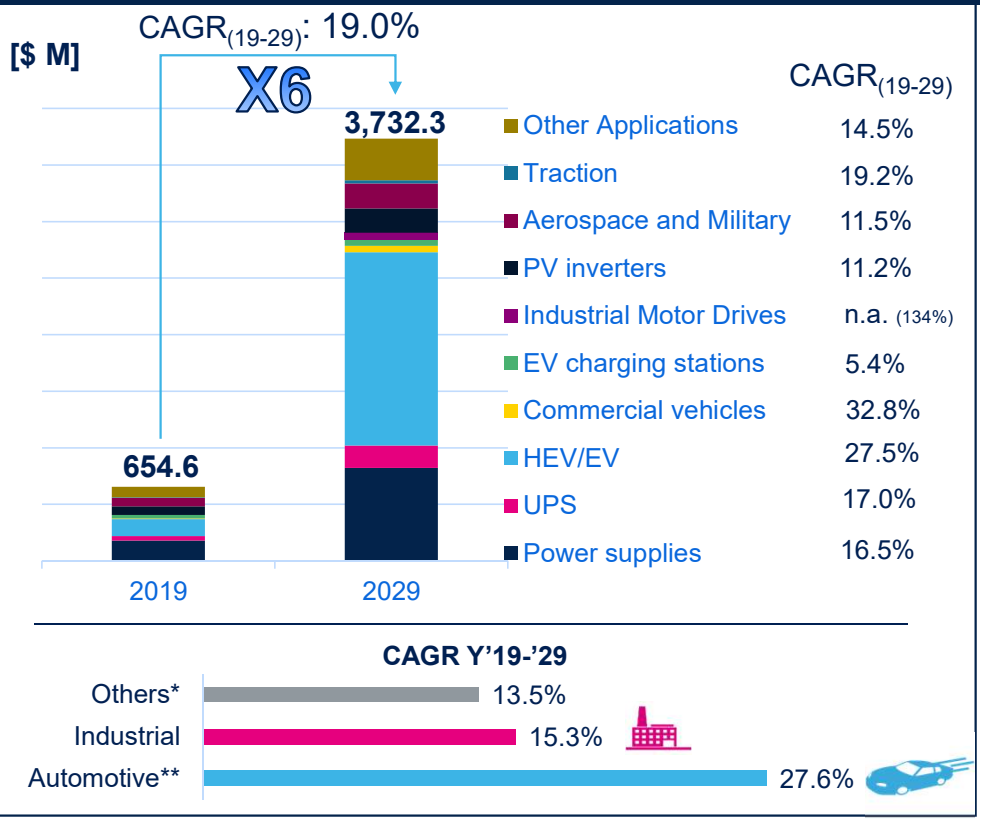
SiC power semiconductors by macro product family



2.4B$ on 2025 (GAGR 19-25: 24.0%)

- **1.2B$** High Voltage Si MOSFET (excluding module) in 2025
- **1.4B$** IGBT (excluding module) in 2025

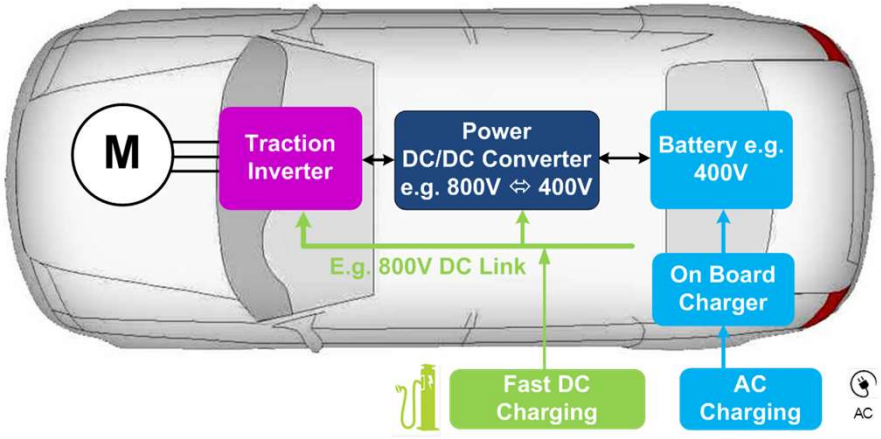
SiC power semiconductors by application



Sources:
Omdia – power-discrete-module-market-tracker-interim Report (April 2020)
Omdia – SiC & GaN World 2020 Forecast & output Tables – mid-case (June 2020)

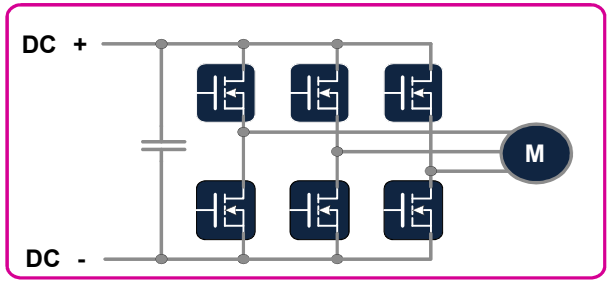
**Military and aerospace, traction, other applications*
***HEV/EV, Commercial vehicles*

Hybrid and electric vehicle applications

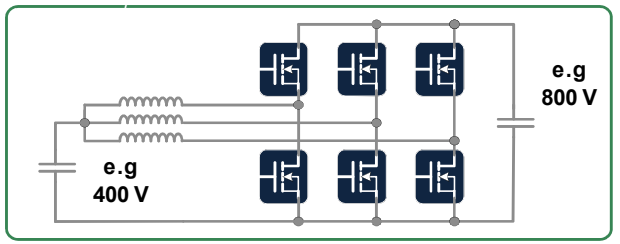


- **SiC MOSFETs are instrumental to reach higher efficiency**, smaller form factor and less cooling complexity with respect to silicon
- High voltage DC-DC converter for fast and reliable **DC Charging** reduces the charging time of HEVs and EVs

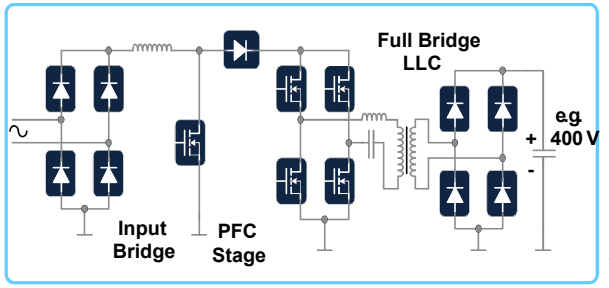
Traction Inverter



HV DC-DC Converter



On-Board Charger



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1200V IGBT vs. SiC MOSFET Benchmark in 210 kW inverter

Traction Inverter Value Proposition

- Power Semiconductors size: Up to 80% smaller
- Cooling System: Up to 60% smaller
- Passive Components: Up to 4x smaller (**)

Up to 50% Overall size reduction

Up to 8% Mileage Extension

Extended life time

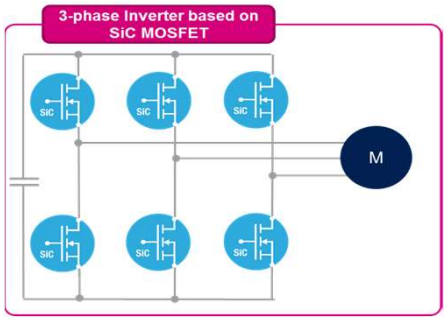
10 kHz

Losses*	IGBT commercial product	Full-SiC 1200 V	
Total chip-area	400 mm² (IGBT) + 200 mm² (diode)	120 mm²	← 5x lower
Conduction losses* (W)	300	307	
Switching losses* (W)	564	143	← 4 x lower
(S1+D1) Total losses* (W)	864	450	← ≈ 2x lower
Junction Temperature (℃)	134.8	132.4	← T_J < 80% Tjmax

* Typical power losses per switch at peak power: 350 A_{rms}

(**) applicable to High Power DC to DC converter when present

- Topology: Three phase inverter
- T_j < 80%*T_{jmax} at any condition
- 200 A_{rms} continuous, 350 A_{rms} peak
- P_{OUT} ≈ peak power 210 kW with MI = 0.95, Cos(phi)= 0.8



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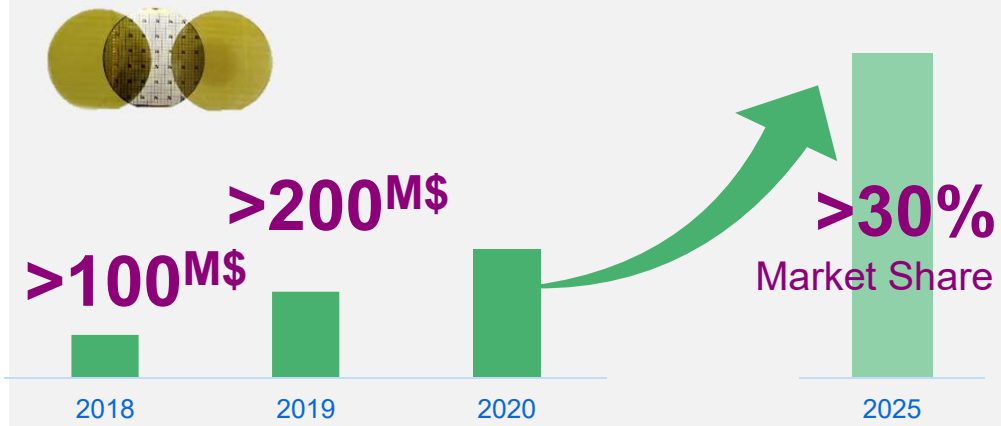
Silicon Carbide: ST 1st player in Automotive

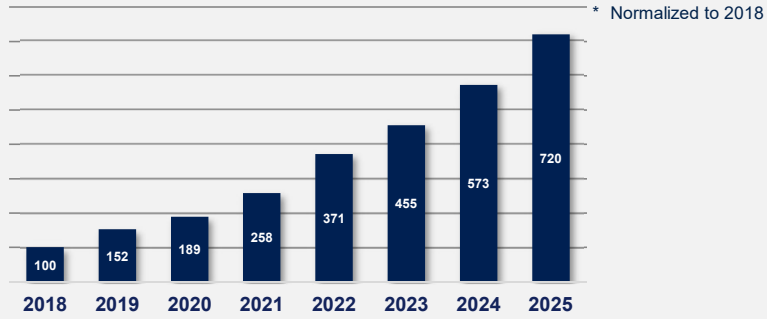
in line with our Target of >30% Market Share by 2025

Silicon Carbide: Business Status



Partnering with major players around the globe

Huge Capacity increase



ST committed in SiC Supply Chain

- **Vertical Integration** through **Norstel AB** acquisition
- **Extended** Supply Chain capability through Multi-Year supply agreement
- Continue **to invest** to expand internal **capacity**

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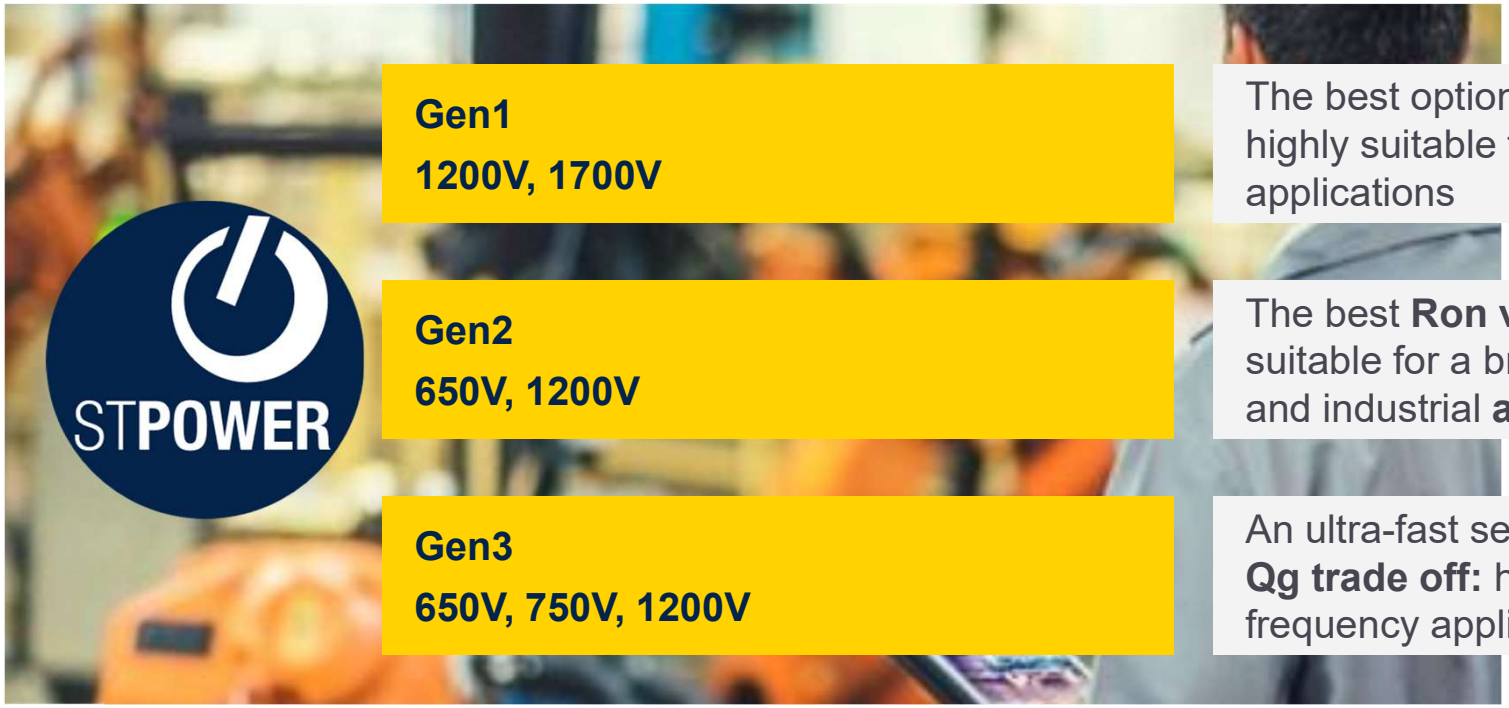
STPOWER SiC MOSFET technologies overview

The best high voltage and high frequency switch for high density applications



Gen1
1200V, 1700V

The best option for **Ron vs. Tj** behavior: highly suitable for motor drive applications

Gen2
650V, 1200V

The best **Ron vs. Qg trade-off** : highly suitable for a broad range of automotive and industrial **applications**

Gen3
650V, 750V, 1200V

An ultra-fast series with the **best Ron vs. Qg trade off:** highly suitable for very high frequency applications

STPOWER Silicon Carbide MOSFET

Best-in-class SiC Technology

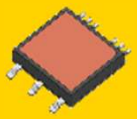
SiC MOSFET exhibits a two-digit growth rate in the **Automotive** domain: ***52% CAGR between 2018 through 2025***

- **ST broad range of SiC solutions:** Discrete, Bare Dice, Module
- **ST** proven very **high reliability**
- **ST continue capacity expansion** to support market acceleration
- **ST invests on advanced package** technologies with:

HiP247-4™ leads

HU3PAK™

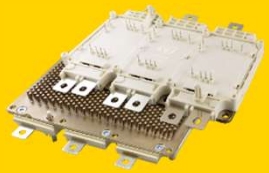
STPAK™



ACEPACK™ SMIT

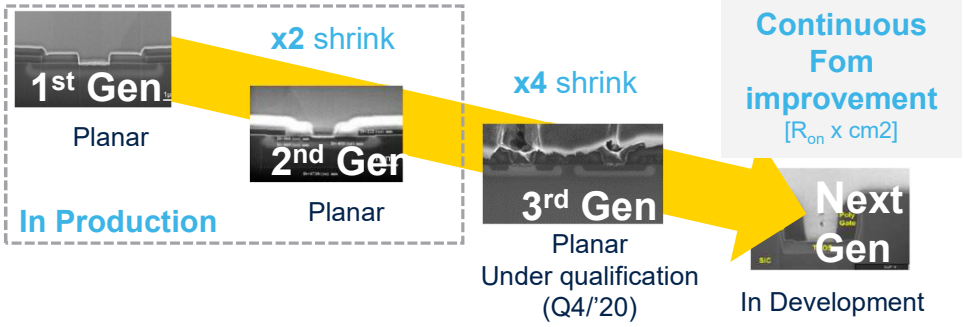
Power Module solution

ACEPACK™ 1 - 2



ACEPACK™ DRIVE

Front-end Evolution



Key Advantages in Automotive

Traction Inverter & On-Board Charger

Charging Station

Car Weight Reduction

Longer Range: **>600 km** with SiC

Less Charging Time
(From 16 to 7 min)

SiC Charging Station handles **2x** Energy
(Fast Charger :350 kW with SiC)

Sources: IHS Market SiC and GaN Power Semiconductors Report, McKinsey

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STPOWER completes offer for (H)EV: in addition to Silicon Carbide

GaN HEMT

650 V and 100 V normally off solutions to boost efficiency and power density thanks to fast switching operation

OBC

48V DC-DC

HV Si MOSFET: MDmesh

OBC and DC-DC converter

series

- **DM** → **Higher Efficiency**
- **K** → **Higher Voltage Range**
- **M** → **More Power Density**

IGBT

Narrow MESA technology → Traction

series

- **M** → Electric heater and aircon
- **V** → OBC and DC-DC

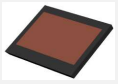
ST commitment

Investing in new facilities to sustain **Power Silicon** growth

Agrate Fab **300**mm

Continue innovation on **Power Package**


2SPAK

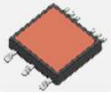

PowerFLAT 8x8 DSC

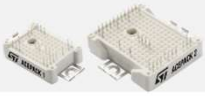

STPAK


TO-LL


PowerFLAT 8x8 HV


HU3PAK


ACEPACK SMIT


ACEPACK 1, 2


ACEPACK DRIVE

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Conclusions

- Le projet G-Mobility pourra bénéficier aussi des produits SiC dans l'automobile. Les partenaires pourront donc avoir accès a cette technologie mature qui s'avère un atout capable de déclencher, avec le GaN, un démarrage de la voiture électrique en France et en Europe en grande échelle
- ST est aujourd'hui le fournisseur principal mondial de produits SiC en volume pour l'automobile
- Contact pour les projets SiC: filippo.digiovanni@st.com

Merci

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