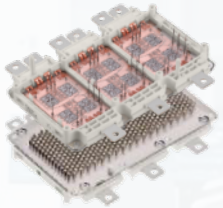


Going the extra mile: HybridPACK™ Drive CoolSiC™

Mark Münzer, Vice President Innovation & Emerging Technologies
3 May 2021

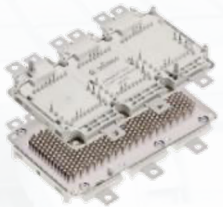
Optimal choice of technology for EV traction inverters

HybridPACK™ Drive CoolSiC™ MOSFET for rear axle



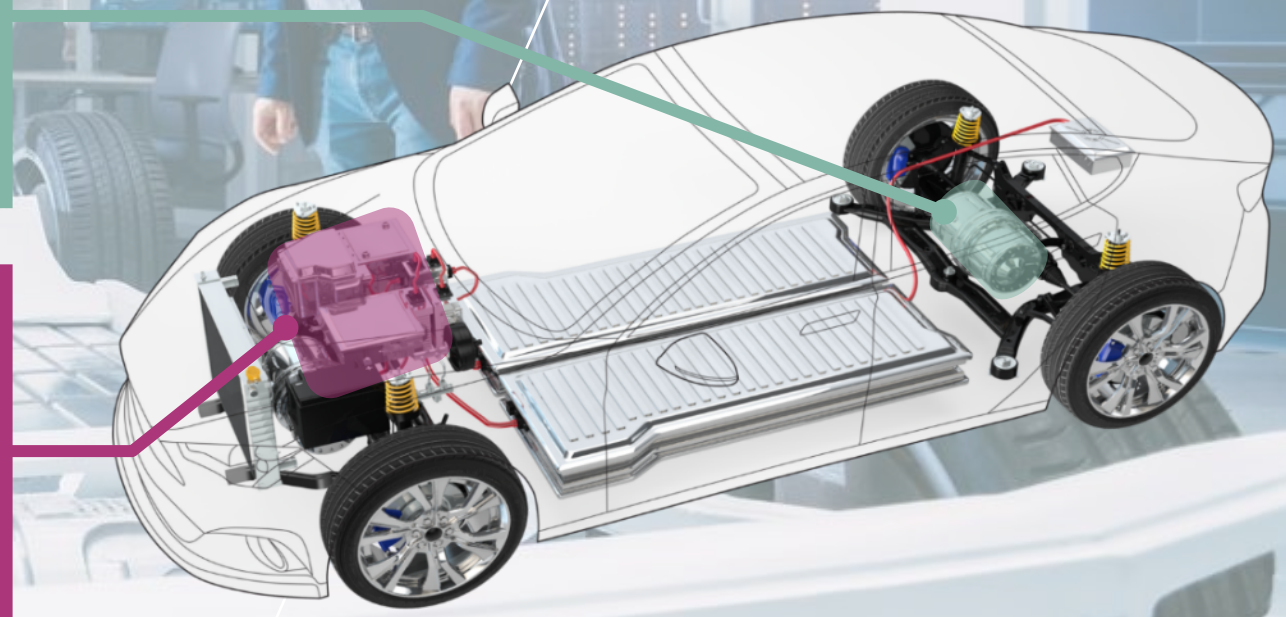
- Focus on
  - Range: **SiC**
  - Cost
    - Large battery: **SiC**
    - Small battery: **IGBT**

HybridPACK™ Drive IGBT for front axle



- Focus on cost : **IGBT**



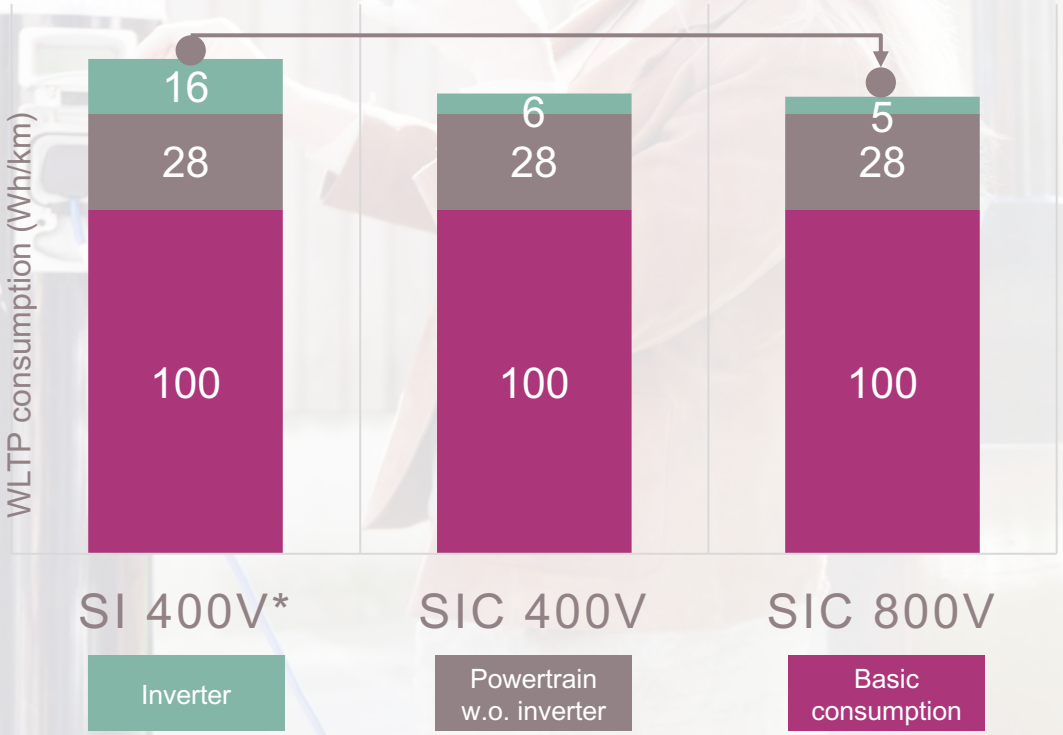


Longer range | Compact size | System cost

SiC reduces energy consumption in main inverter by 69%



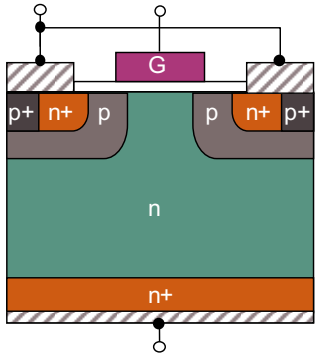
Energy reduction 7.6%



Si: 750V EDT2 IGBT; SiC: 1200V CoolSiC™ MOSFET
Source: ‚effect of a SiC TMOSFET in tration inverter of electric drive train', PCIM 2018

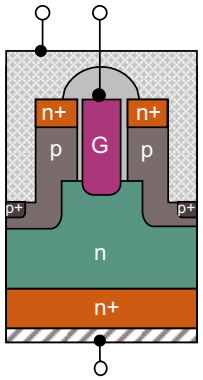
SiC Trench technology out-performs Planar demonstrating more protection vs. traditional Trench

SiC Planar



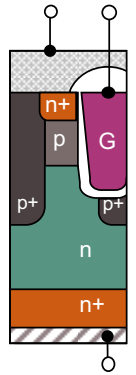
- ✓ Low complexity process
- ✓ Good shielding of oxide possible

SiC Trench



- ✓ Low channel resistance
- ✓ Shrink potential higher than in planar DMOS

Infineon Trench



- ✓ Low channel resistance
- ✓ Shrink potential higher than in planar DMOS
- ✓ Oxide corners shielded by folded double trench
- ✓ Long experience in trench know-how

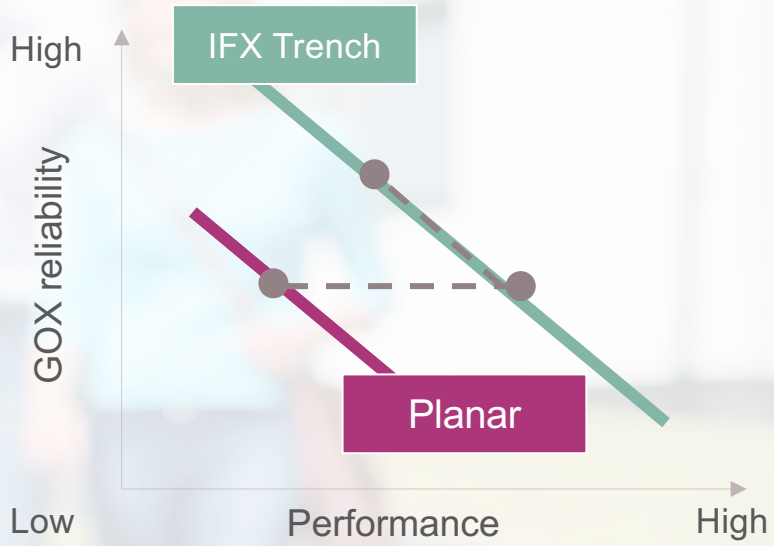
- ○ Sophisticated process know-how needed

- x Very low channel mobility
- x Limited shrink options
- x Protection of oxide corners needed

Copyright © Infineon Technologies AG 2021. All rights reserved.

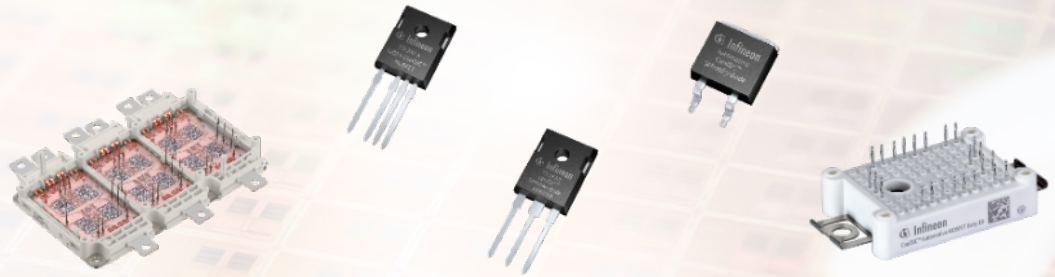
CoolSiC™ optimized performance and reliability

Turn performance budget into best reliability



Instead of exploiting full potential of performance, IFX turns this budget into much higher reliability

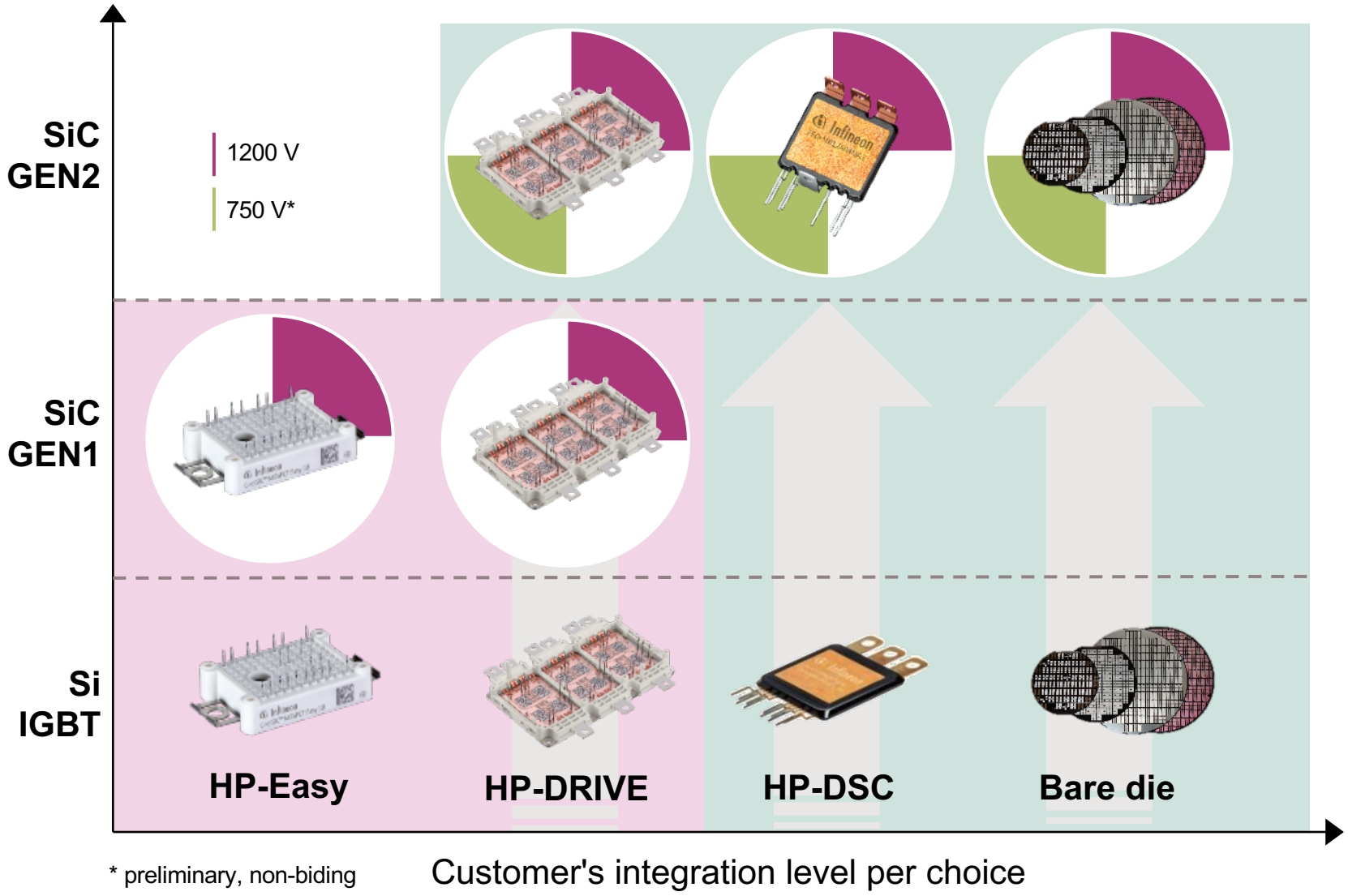
TRENCH excellence acknowledged in the market



Multiple planar vendors announced TRENCH roadmap 2022+

- Infineon has accumulated years of expertise in Trench tech already
- Infineon’s refined Trench offers higher reliability vs. other vendors

Main Inverter: scaling from Infineon Si to SiC
HP-Drive™ CoolSiC™ offers safe migration to shorten T2M

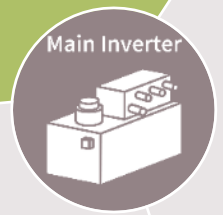


'Develop the best solution for your strategy based on industry's only complete CoolSiC™ power portfolio:

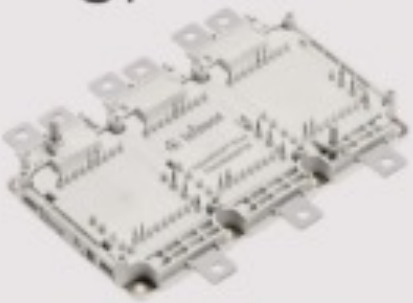
Performance, cost, time to market, support, high volume capability @ Infineon Quality'

Copyright © Infineon Technologies AG 2021. All rights reserved.

Scalable HybridPACK™ Drive CoolSiC™ Solution



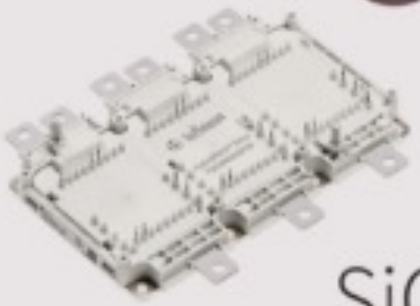
Si











SiC

For the same footprint,
SiC allows to scale the inverter
to higher power

Success story of HybridPACK™ Drive

25
years of Experience
↓
EDT2

More than 1 Mio. pcs shipped

- **25** years of IGBT/Diode Know-how
- > **25** successful customer relationships
- Ramp-up in > **10** worldwide platforms in next 2 years
- **>20** BEV platforms with HybridPACK™ Drive in production

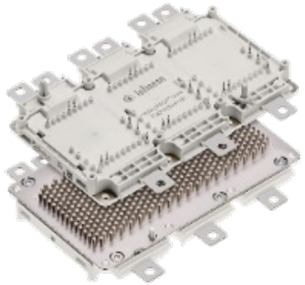
>20
platforms
↓
HybridPACK™ Drive

XPeng: P7

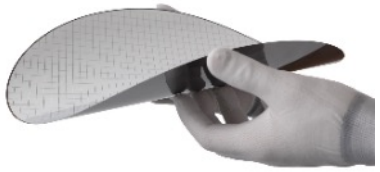


Nio: ES8, ES6, EC6





Infineon Power Technology Inside



Volkswagen: ID.3 and MEB cars





Infineon is partner in Volkswagen's strategic supplier network FAST

Li Auto: LiXiang One



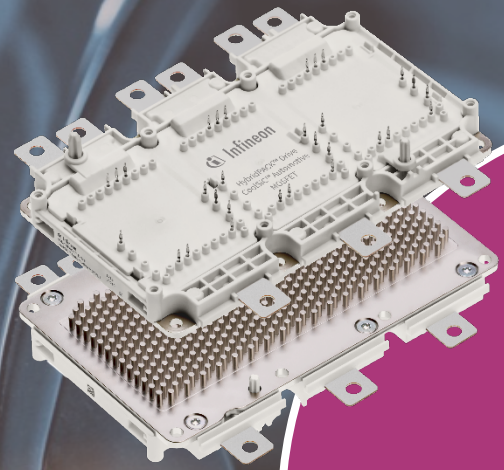
Weltmeister: EX5



Copyright © Infineon Technologies AG 2021. All rights reserved.

First automotive frame module in the market

SiC



1st

Hyundai has chosen Infineon's CoolSiC™ products for their next generation EVs

General CoolSiC™ value contribution to customers

Higher mileage with the same battery capacity

› Trench based SiC devices increase power efficiency compared to alternative technologies

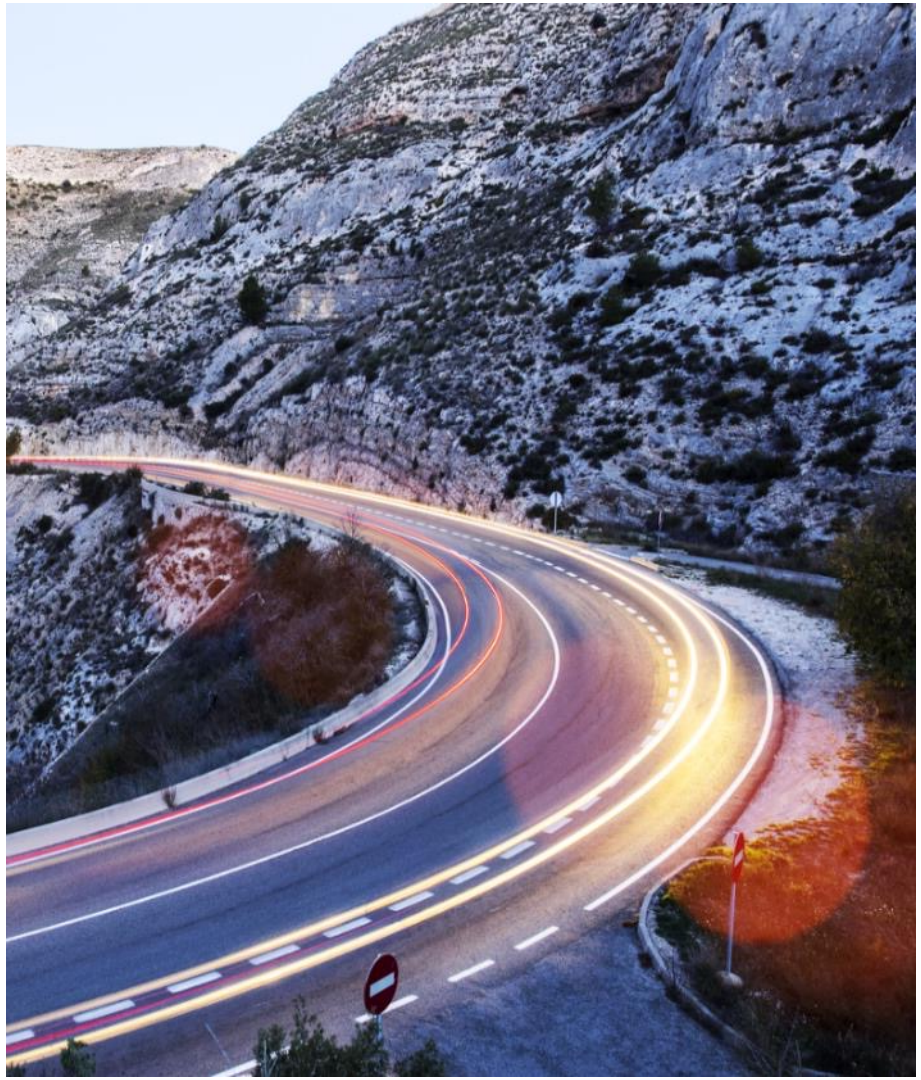
Easy scalability from IGBT to SiC-based inverters

› HybridPACK™ CoolSiC™ power modules and EiceDRIVER™ high-voltage drivers allow upgrade from IGBT to SiC in the same footprint

Additional value for Infineon's customers

› Unique automotive quality and reliability levels

› High-volume production track record of dedicated electro-mobility products

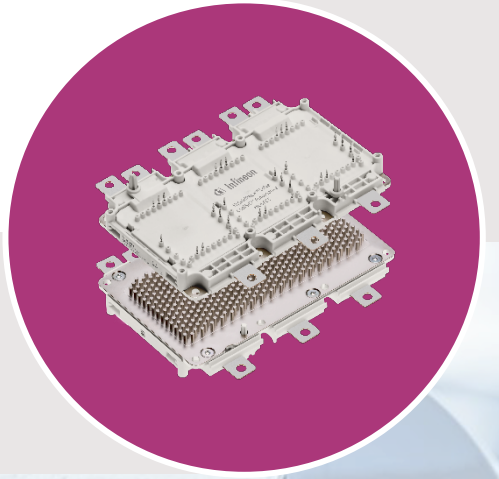


Copyright © Infineon Technologies AG 2021. All rights reserved.

HybridPACK™ Drive CoolSiC™ MOSFET
1200 V SiC for EV Traction inverter scalable from Si counterpart

Features

- B6 **Full-bridge** module
- Vbr=1200 V; Output power **scalability** with chip population
- **Direct Cooled pin-fin base plate**
- Hybrid-PACK™ Drive: **Same package** as IGBT B6 module



FS05MR12A6MA1B

1200 V / 200A (4 chips per switch)

RDS(ON) typ. 5.5 mΩ

FS03MR12A6MA1B

1200 V / 400A (8 chips per switch)

RDS(ON) typ. 2.75 mΩ

Benefits

- Increasing battery utilization by **5-10%**
- **Higher power density** for system size reductions
- **Lower conduction losses in light load** condition and lower switching losses compared to Si IGBTs

Source: Infineon internal accessment, Oct. 2020

Copyright © Infineon Technologies AG 2021. All rights reserved.

CoolSiC™ EVKIT optimized for both 400 and 800 V

SiC

12 V Battery

Logic Board

AURIX™

PCB connector

Gate Driver Board

ED-E Enhanced

EiceDRIVER™-E

PressFIT

HV Battery

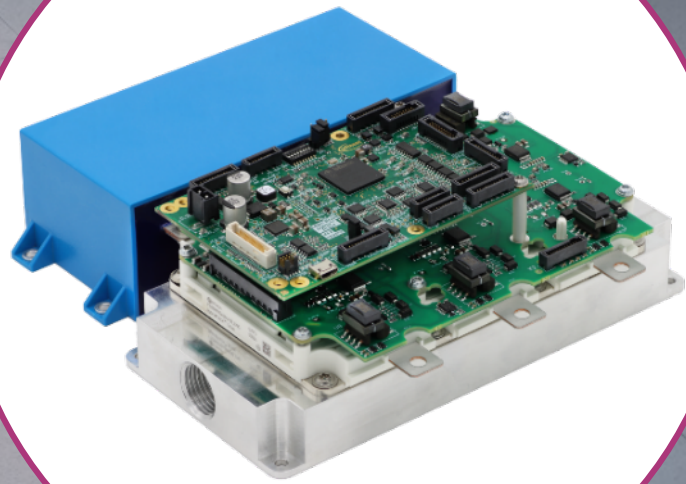
Power module

HybridPACK™ Drive CoolSiC™ MOSFET

Water Cooling System

Galvanic Isolation

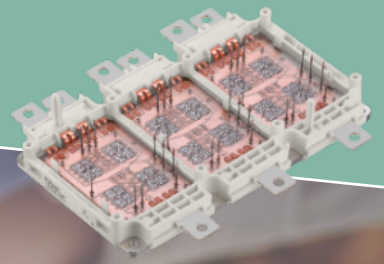
M 3~



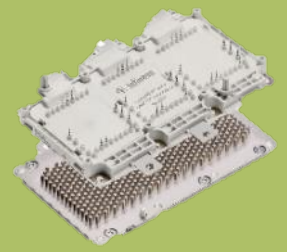
Q3-2021

Technical support material available

SiC

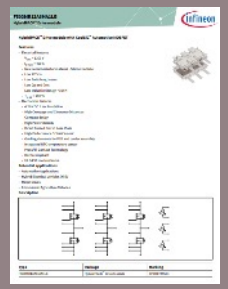


Samples



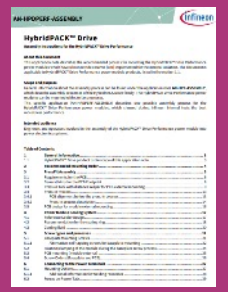
Available

Data sheet



Available

App note



Available

IPOSIM



May 2021

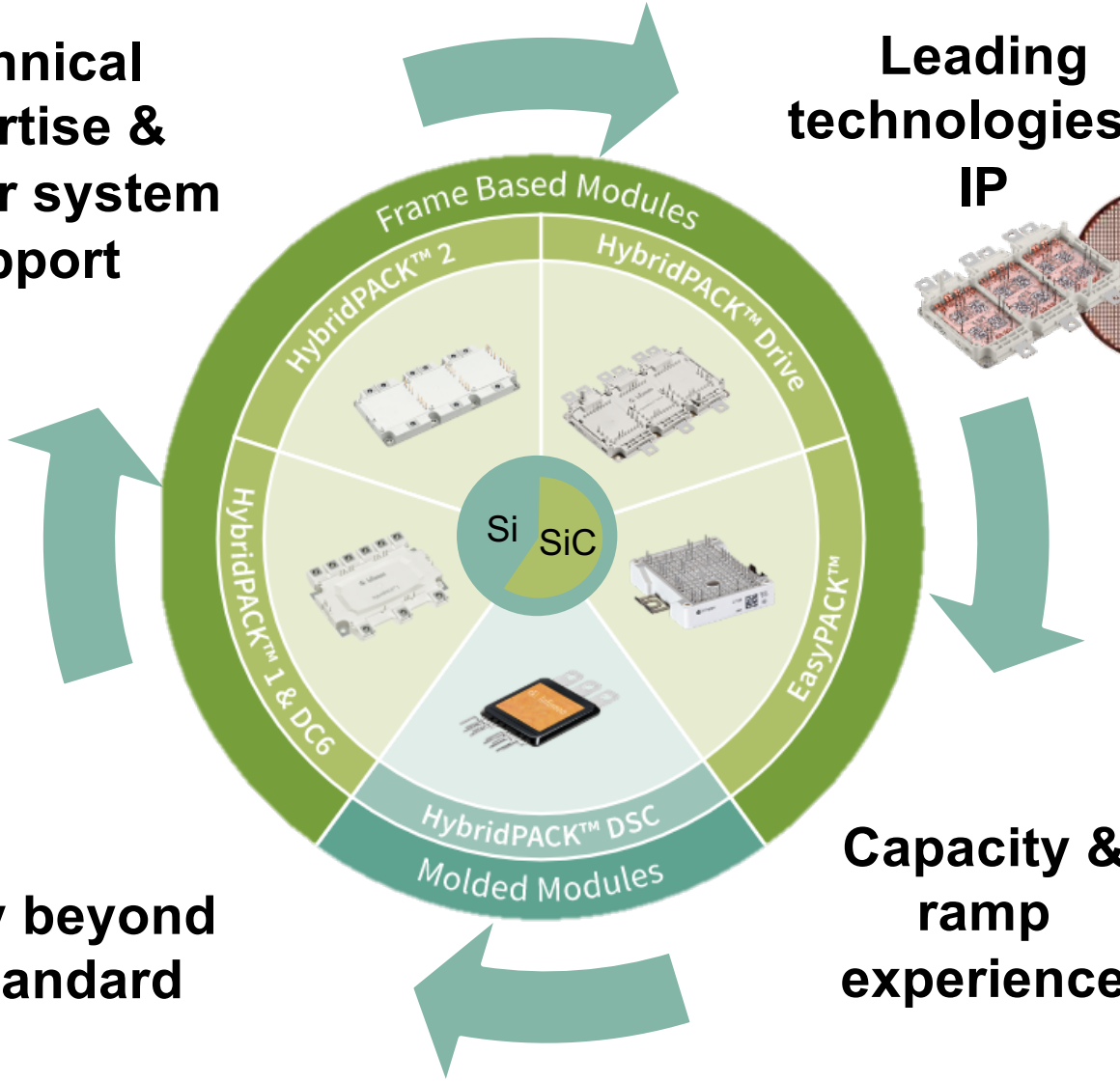


Part of your life. Part of tomorrow.

Infineon is the dependable partner with leading technologies and industry's broadest portfolio for electric vehicle inverters



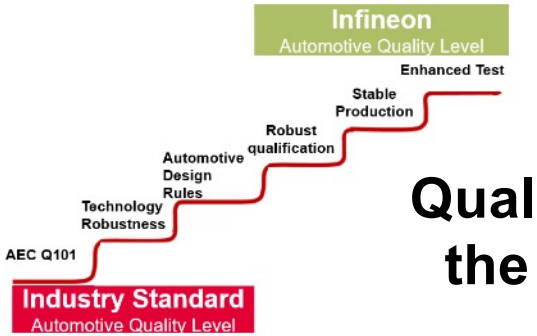
Technical expertise & inverter system support



Leading technologies & IP

Capacity & ramp experience

Quality beyond the standard



15+ years
experience in electromobility

Hybrid-PACK™ patented

HybridPACK™ drive Design & Brand registered
Including the US
Innovation protected by patent portfolio

1 Mio
pcs Hybrid Pack™ Drive™ sold

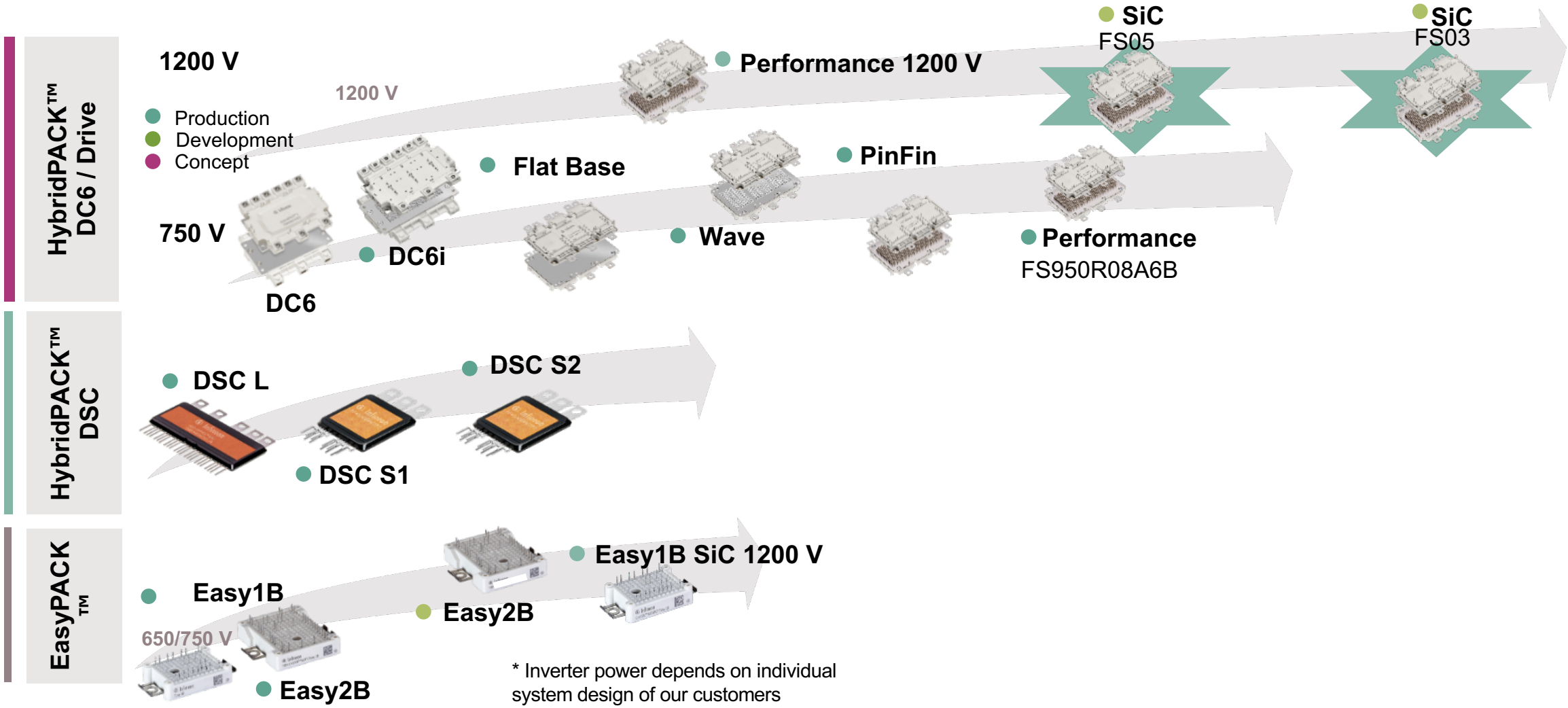
18 Mio
pcs Automotive Power Modules shipped to date

15 out of 20
top-selling NEV of 2019 powered by Infineon

Copyright © Infineon Technologies AG 2021. All rights reserved.

Scalable portfolio of Si / SiC
HybridPACK™ SiC GEN1 chosen by leading OEMs

~ Power Class*	Medium		High			Ultra High
	<60 kW	80 kW	120 kW	150 kW	180 kW	>180 kW



* Inverter power depends on individual system design of our customers

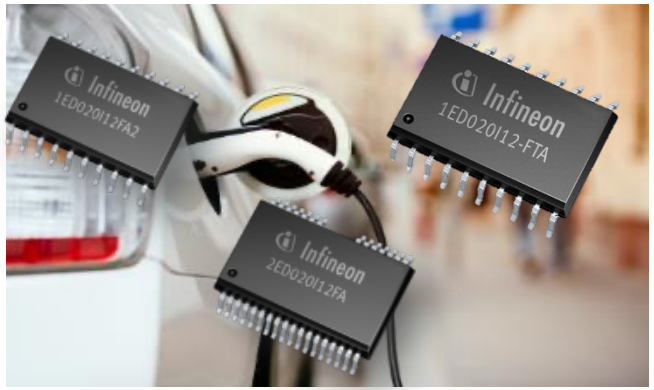
Copyright © Infineon Technologies AG 2021. All rights reserved.

Main inverter remains key focus application for Infineon

2009 → **2015** → **2020**

Automotive EiceDRIVER™ as integral part of the Infineon main inverter chipset solution

1st Generation
Automotive HV gate drivers for xEV applications



2nd Generation
Performance and flexibility



3rd Generation
Integration, efficiency and optimization



Galvanic isolated gate drivers for automotive main inverter applications are in volume production since 2009.
Used in more than 50 automotive (PH)EV platforms worldwide.

Copyright © Infineon Technologies AG 2021. All rights reserved.