

StarPower Semiconductor Ltd.  
StarPower Europe AG



# Company Introduction



- Established: on April 27, 2005
- Campus: 70,700 m<sup>2</sup>
- Total employees: 500
- Revenue in 2017: US\$ 95 million (2016: US\$ 80 million)
- Locations China: Jiaxing (FAB1, 2 and 3), Shanghai (FAB4)
- Locations Europe: Nürnberg/ Germany (R&D), Cadenazzo/ Switzerland (Sales HQ)
- Certificates: [ISO9001](#), [ISO14001](#), [TS16949](#)



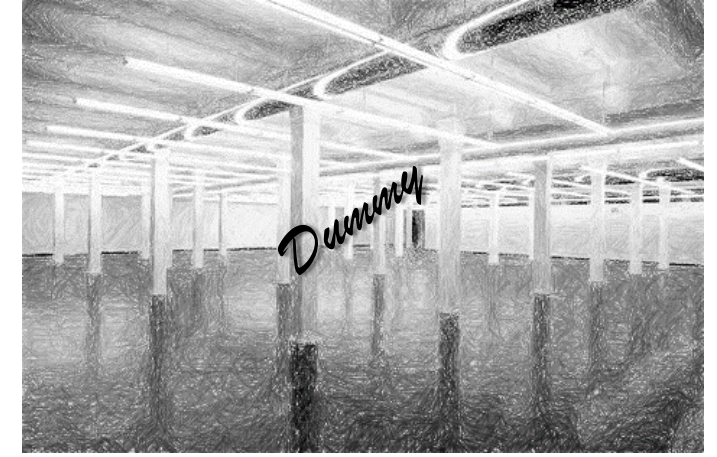
Fab 1

- Clean Room Area: 1200m<sup>2</sup>
- Standard Module Production (600V / 1200V / 1700V)
- Capacity / Month: 150k pcs.



Fab 2

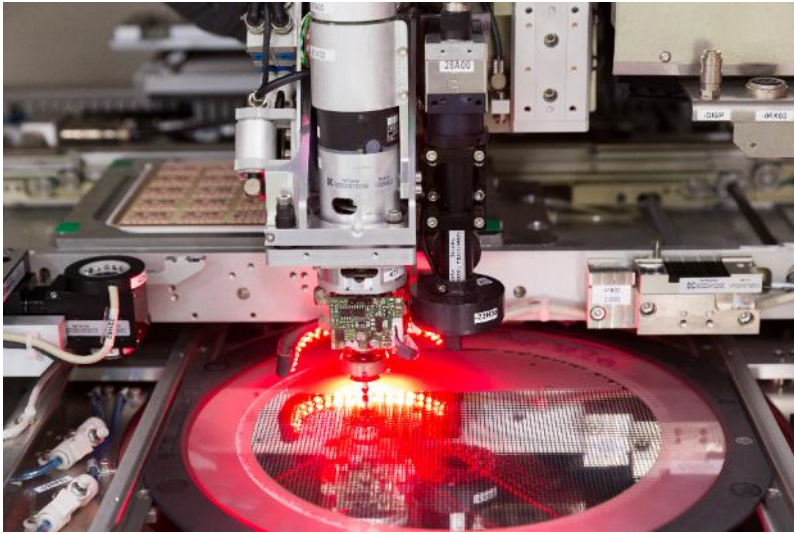
- Clean Room Area: 2000m<sup>2</sup>
- L- and F- Types (6-pack, 7-pack, CIB)
- Capacity / Month:  
100k pcs. (Econo)  
100k pcs. (Easy/ Flow)



Fab 3

- Clean Room Area: 1500m<sup>2</sup>
- Planned for IPM Modules (600V / 1200V) for white goods and other applications

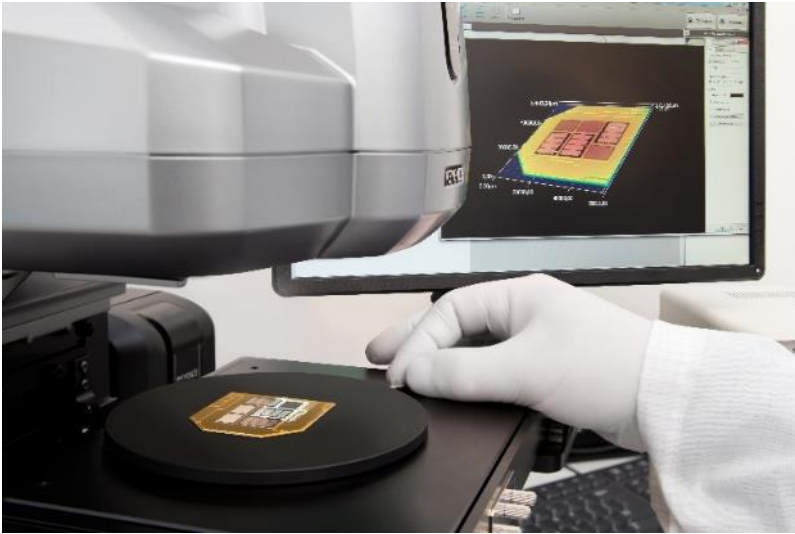
# Production



# Automotive Module Production

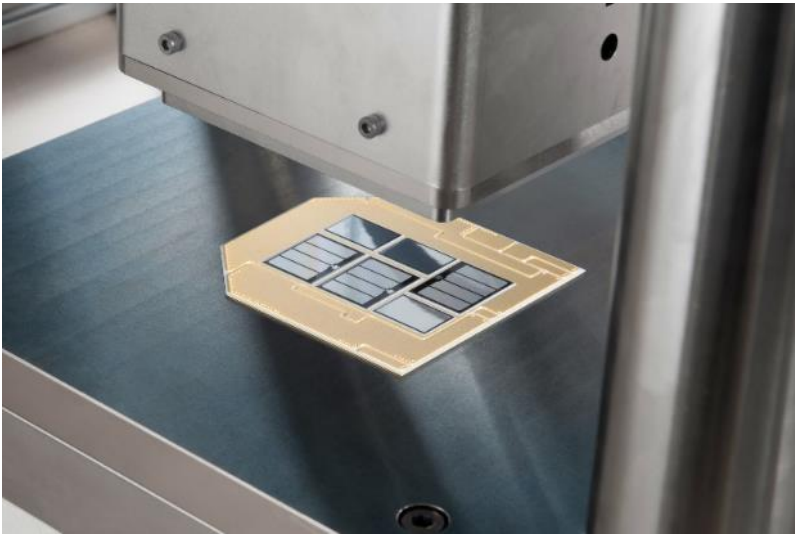


- Introduced by Shanghai government
- Located in Shanghai New Energy Vehicle Science Park
- Will focus on IGBT modules for EV application
- Ready for production in Q2, 2018
- Phase I Capacity about 50k of automotive modules per month



**Development of new Technologies**

**(i.e. Sintering, New Die bonding, etc)**



# Key Personnel



**Dr. Hua Shen**

CEO

StarPower

11 years

Production experience at Siemens / Infineon in USA and Xilinx Inc. USA

**Peter Frey**

Managing Director

StarPower Europe

23 years

Sales & Marketing Director at SEMIKRON

**Christian Kroneder**

Director  
R&D Center  
StarPower Europe

19 years

R&D experience and Leader of component development at SEMIKRON

**Dr. Yi Tang**

VP  
Silicon Technology  
StarPower

12 years

R&D Experience in Power Device Technology development at International Rectifier

**Dr. Subhas Bose Veeramma**

Director & CTO  
Chips  
StarPower Europe

19 years

Production, R&D and Line Manager experience at ITI / IXYS / ABB
















# Key customers China





# StarPower position in Chinese Automotive Market



Main Customers		End Customers
Shanghai EDRIIVE CO. Ltd		  
Shenzhen Inovance Technology Co.		
Shanghai DAJUN Technologies INC		 
HUAYU Automotive Systems Co. Ltd		
Jee Automation Equipment Co. Ltd		
Shenzhen V&T Technologies Co. Ltd		

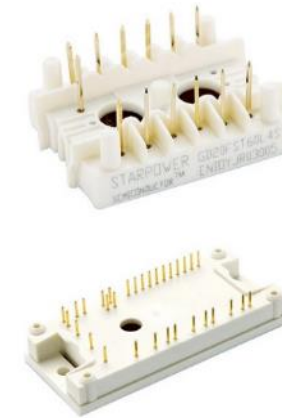
# Key Customers StarPower Europe



# IGBT Modules – Standard Range

**Low power modules**

**650V - 1700V**



**Half bridge**  
**75A – 200A**

**Full bridge**  
**30A – 100A**

**PIM**  
**10A – 150A**

**3 Level**  
**30A – 150A**



# IGBT Modules – Standard Range



**Medium power modules**

**600V - 1700V**



**Half bridge**  
**50 – 600A**

**3 phase**  
**100 - 800A**

**Chopper**  
**40 – 400A**

**3 Level**  
**100 – 400A**

**Single**  
**200 – 800A**



# IGBT Modules – Standard Range

**High power modules**

**1200V - 3300V**



**Single**  
**400 – 3600A**

**Half bridge**  
**200 – 1400A**

**3 Level**  
**650A**

**Chopper**  
**450 – 1400A**



## Chip - Sintering

- Increase module reliability by up to factor 3
- Allows for higher  $T_j$
- Improves thermal resistance



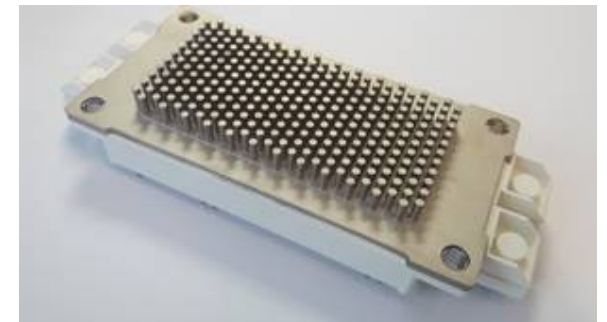
## Pressfit

- Low thermal and electrical contact resistance
- Gas-tight contact and high contact force
- Increased system reliability, especially in harsh environment

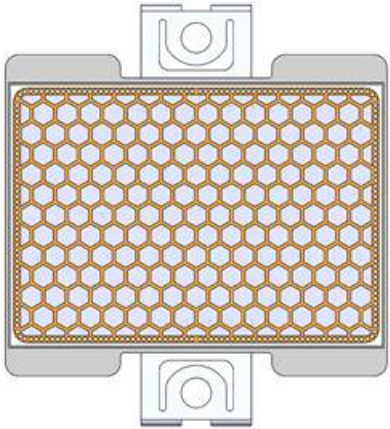


## PINFIN

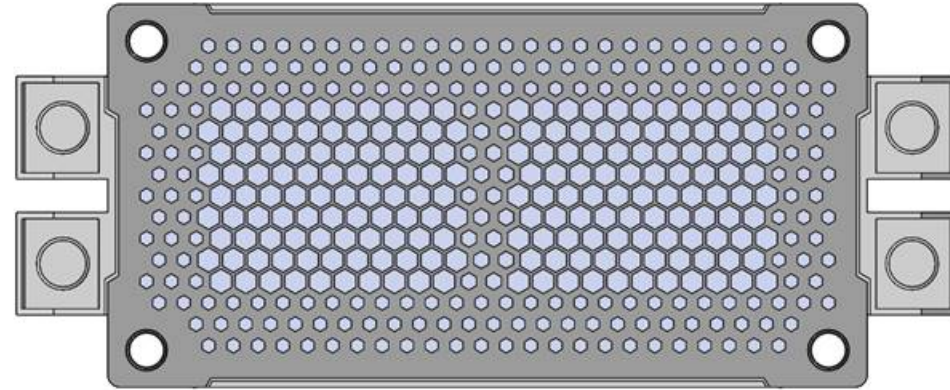
- The PINFIN heat sink geometry to provide increased surface area for heat transfer, low thermal resistance from base to fins
- Lower thermal resistance -> lower operating temperature or high power densities



## TIM



- Soft material at all temperatures
- Optimum for modules without baseplates
- Higher output power, higher lifetime



- Solid material at low temperatures
- High performance thermal paste with 30% improved Rthjs

## High Temperature Silicone Gel

- $T_{jop} = 175^{\circ}\text{C}$  possible
- High temperature silicone gel passes, in combination with special Chip passivation, the HVH3TRB Test

## StarPower Chip design

- Chips designed internally and produced in Chinese foundry

### NPT IGBT (1200V / 1700V)

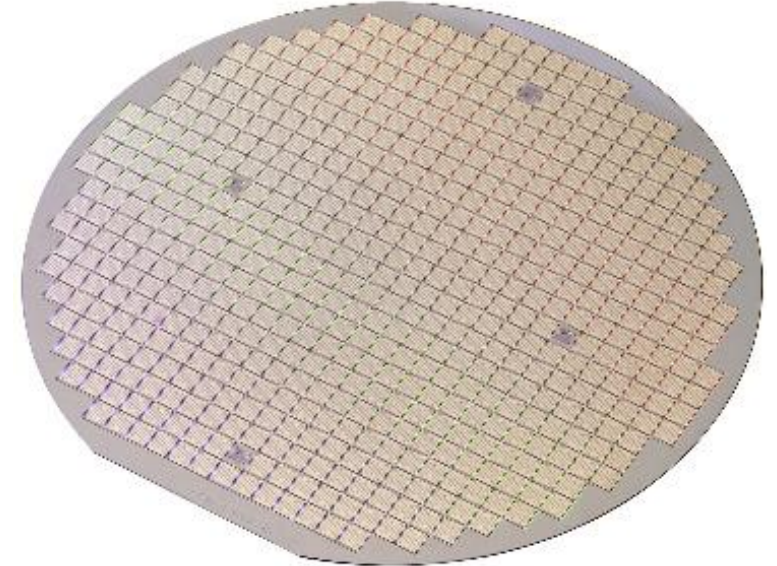
- In production more than 3 years
- Widely used in inverter / UPS / Welding application
- 20% of current IGBT modules are sold with StarPower IGBT's

### Trench with Field Stop IGBT (650V / 1200V / 1700V)

- 1200V in Series production since Dec 2015
- 650V in Series production 2017
- Widely used in inverter / UPS / Welding application / Automotive application

## External Suppliers

- Work with strong, reliable and reputable partners: Infineon, ABB, Ixys, Vishay





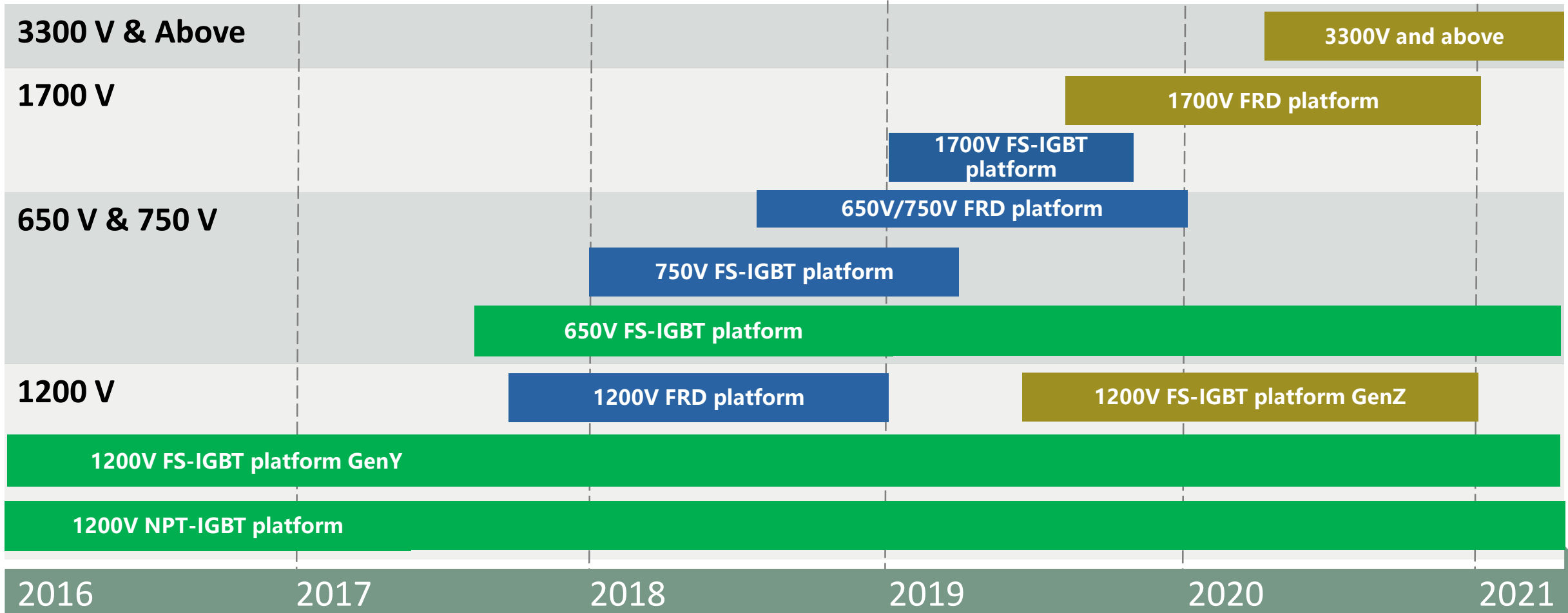
- 1200V NPT-IGBT
  - In Volume production > 5 years
- 1200V FS-IGBT
  - In Volume production > 2 years
- 650V FS-IGBT
  - In Volume production since Q4 2017
- 750V / FS-IGBT
  - In development, Samples available Q3 2018
  - Qualification Q4 2018
- 1700V FS-IGBT
  - In development, 1st 75A sample available Q4 2018
  - Other die sizes sample available Q1 2019
  - Qualification Q2 2019

# Trench FS-IGBT & FRD Roadmap



**Roadmap:** Develop a wide range of Power IGBT and FRD platforms, to supply all StarPower IGBT module requirements.

Future Platforms	Platforms under development
	In Production



- **Wide range of standard packages** available for SiC implementation
- Optimized SiC package (Starpower development) for SiC (ultra-low inductance, optimized thermal design)
- Flexible die sourcing depending on customer requirements
  - **Key partners: USiC, Rohm, Cree**
- **In-house package design capability** with long experience in module design and optimization
- **In-house process capabilities** required for SiC processing (i.e. **Die Sintering**)
  - **Focus currently on custom projects** with launch of standard modules planned in future



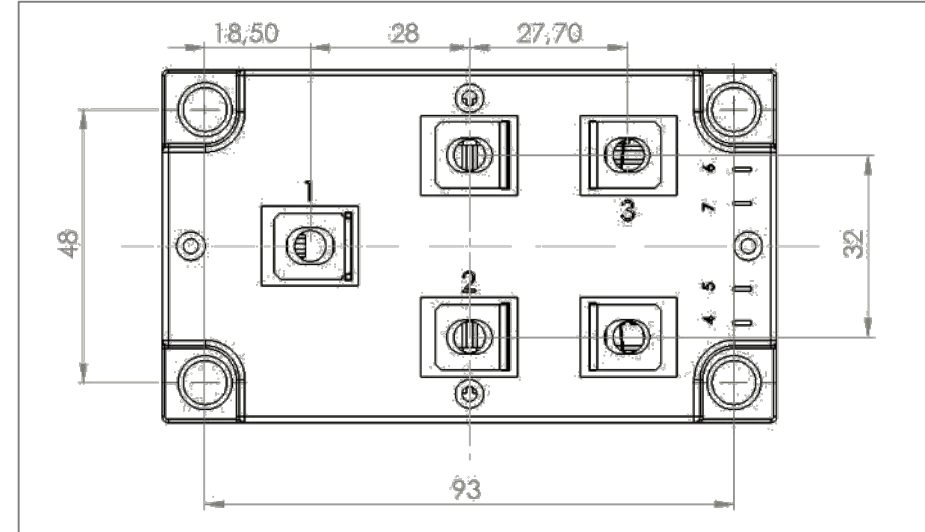
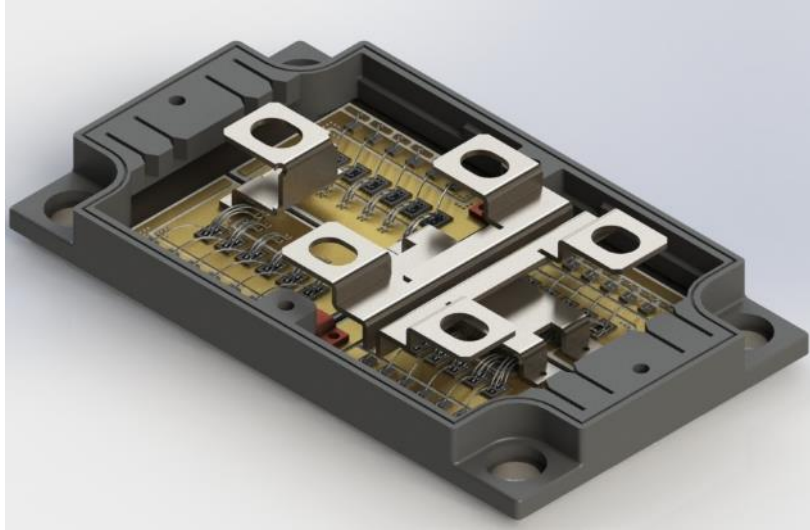
MD120HFR120C2S	MD300HFR120C2S	MD250HFR170C2S
$V_{DSS} = 1200V$	$V_{DSS} = 1200V$	$V_{DSS} = 1700V$
$I_D @ T_C 100^\circ C = 120A$	$I_D @ T_C 100^\circ C = 300A$	$I_D @ T_C 100^\circ C = 250A$
$T_{jop} = -40^\circ C / +150^\circ C$	$T_{jop} = -40^\circ C / +150^\circ C$	$T_{jop} = -40^\circ C / +150^\circ C$
$R_{DS(on)} @ T_j 25^\circ C = 10m\Omega$	$R_{DS(on)} @ T_j 25^\circ C = 5m\Omega$	$R_{DS(on)} @ T_j 25^\circ C = 8.3m\Omega$

Package optimised for requirements of SiC chips

→ Optimized thermal management with  $T_{jmax}$  at  $175^\circ C$

→ Sintered chips for significantly improved reliability compared with soldering

(Competitor parts in same housing use soldered chips. **Reliability** increases by about **factor 3** due to **sintering**.)



Package: B → Case height = 17mm

Package optimised for requirements of SiC chips

- Ultra **low package inductance** of **8nH**
- Optimized thermal management with  **$T_{jmax}$  at 200°C**
- **Sintered chips** for significantly improved reliability compared with soldering

MD300HFR120B3S	MD350HFR120B3S	MD400HFR120B3S
$V_{DSS} = 1200V$	$V_{DSS} = 1200V$	$V_{DSS} = 1200V$
$I_D @ T_C 100^\circ C = 300A$	$I_D @ T_C 100^\circ C = 350A$	$I_D @ T_C 100^\circ C = 400A$
$T_{jop} = -40^\circ C / +175^\circ C$	$T_{jop} = -40^\circ C / +175^\circ C$	$T_{jop} = -40^\circ C / +175^\circ C$
$R_{DS(on)} @ T_j 25^\circ C = 5m\Omega$	$R_{DS(on)} @ T_j 25^\circ C = 4m\Omega$	$R_{DS(on)} @ T_j 25^\circ C = 3.3m\Omega$

# Reliability test equipment



HTRB/HTGS



THB



Power Cycling



Low Temperature Storage



High Temperature Storage



Thermal Cycling



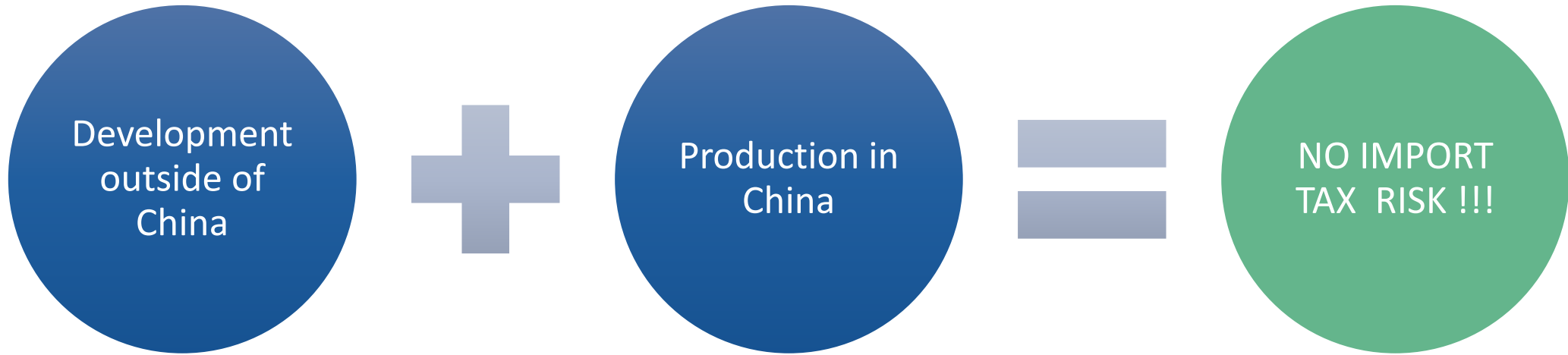
Vibration

# Qualification tests



Test	Parameter set	Standard
HTS	$T_a=140\pm 5^\circ\text{C}$ ( $T_{j\text{max}} = 175^\circ\text{C}$ ) 1000h	
LTS	$T_a=-40^\circ\text{C}$ 168h	acc.3K3 EN60068-2-1
HTRB	$T_j=150\pm 2^\circ\text{C}$ ( $T_{j\text{max}} = 175^\circ\text{C}$ ) $V_{ce}=0.8*V_{ce}(\text{max})$ , 1000h	EN60747-9 (chip qualification)
HTGS	$T_j=150\pm 2^\circ\text{C}$ ( $T_{j\text{max}} = 175^\circ\text{C}$ ) $V_{ge}=20\text{V}$ , 1000h	EN60747-9 (chip qualification)
H3TRB	$T=85\pm 2^\circ\text{C}$ H: $85\pm 5\%$ , $V_{ce}=80\%V_{ce}(\text{max})$ , 168h (Standard) (1000h) internal	acc.to 60068-2-67 EN60749-5
TWT	$-40\pm 5^\circ\text{C} \dots 125\pm 5^\circ\text{C}$ 200 cycles, each 45min	EN60747-9
Vibration	5g, 10Hz-500Hz, 26sweeps, 3h	EN60068-2-6
Shock	30g, 6 directions, 100x per direction	EN60068-2-29Eb
PC	$\Delta T=110^\circ\text{C}$ @ $T_j=150^\circ\text{C}$	EN60749-34

# Your Advantage: No import tax







Dream is driven by quality



Thank you