Vincotech

VIN DC Charger Product Solutions

KIPE Conference

Dr. Evangelos Theodossiu
Sr. Product Marketing Manager
02.07.-04.07.2024

VIN DC Charger Product Solutions

VIN DC Charger Product Solutions

DC Charger Market

DC Charger Market

Charging Station

DC Charger
with integrated power conversion stages and Charger posts

DC Charger
with separated power conversion stages and Charger posts

Charging Points
A charging point is a cable equipped with a socket that allows the charger to connect to the EV

Charger modules
A charger module is a single power conversion stage with a specific power rate

Charger Post
A charger post is an interface that enables energy transfer from the power conversion stage to the EV HV battery

Power conversion stage
The power conversion stages transform AC from the HV/LV transformer to DC, which will be used to charge the EV high-voltage battery via a charger post

DC Charger Market

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VIN Target Application

Slow charging

11 kW

3,5 h*

AC charging
- Conversion done by Onboard charger (OBC)
- Power limited by OBC, most commonly rated 7kW or 11kW, max. 22kW

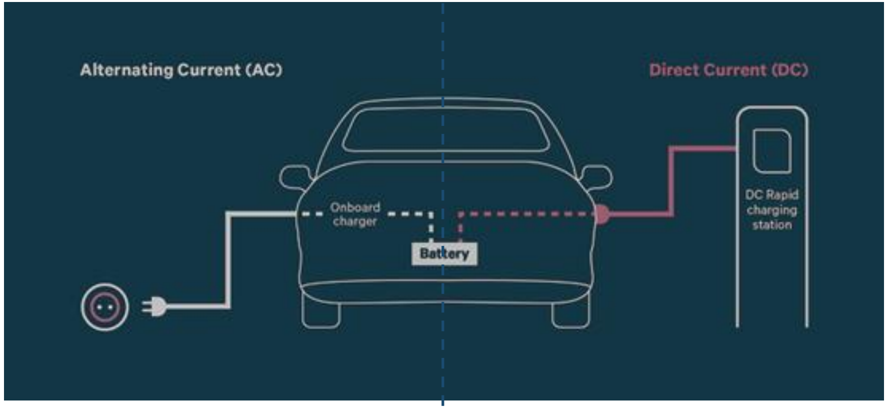
DC charging
- Off-board charger
- Highest power up to 350kW
- Current nominal power lower or equal to 50kW
- Shortest charging times

Fast charging

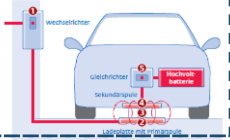
22 kW Home **1,7 h***

50 kW Public **45 min***

350 kW Highway **6 min***



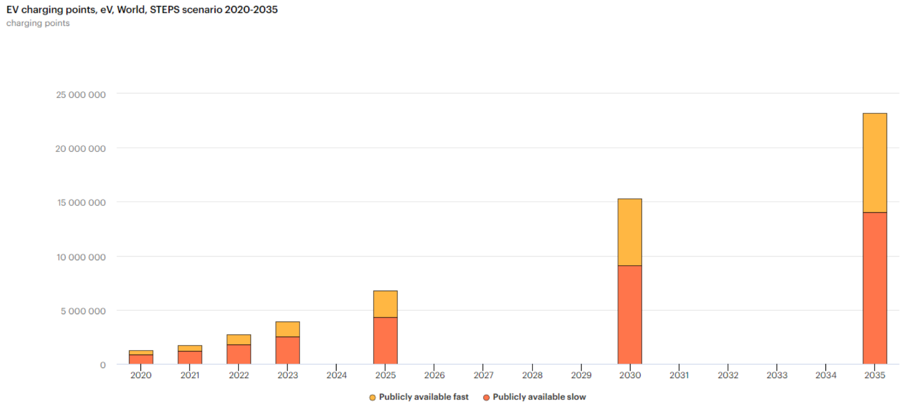
Inductive Charging
- Wireless energy transfer
- Limited Power, up to 20kW
- Efficiency slightly higher than 90%
- Still a niche solution for now



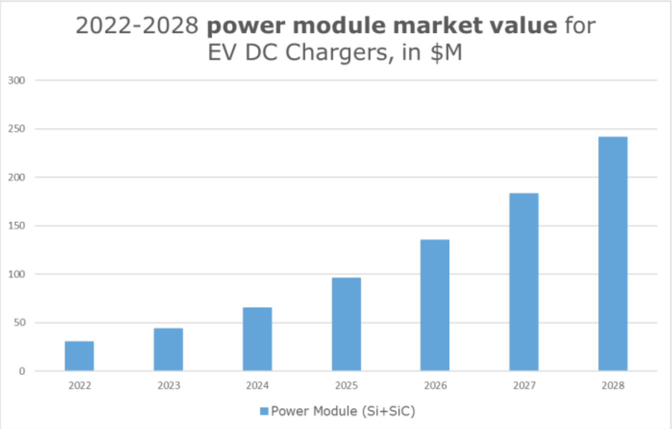
*Charging time for 190km @ 80% SoC, assuming an avg EV battery capacity of 48kWh and an avg EV consumption of 20kWh/100km

DC Charger Market

- The two closely interlinked markets – xEVs and EV charging infrastructure – are growing rapidly
- At the end of 2023, there were 3.9 million public charging points worldwide**, more than 1.2 million of which were installed in 2023, about a 44% increase on 2022 stock. The projection to 2030 is 15 million public charging points worldwide
- The total EV DC charger market value will reach $17.9 billion by 2028, and the power device market value for DC charger will reach $610 million by 2028*
- Currently the power device market value for DC chargers is largely dominated by discrete devices. The share of power modules (IGBT and SiC) will increase rabidly in the coming year. Although silicon devices will continue to dominate the EV DC market, the SiC MOSFET device market will grow rapidly



source: **IEA Global EV Outlook 2024

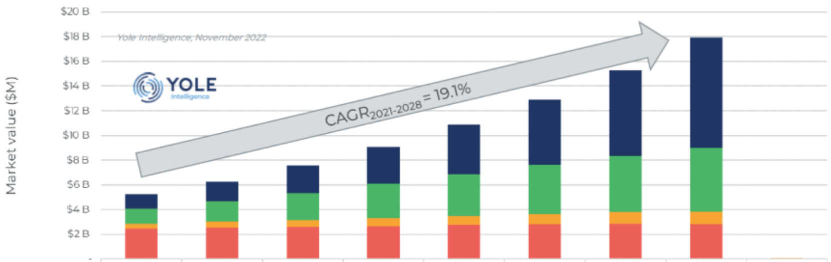


* Yole DC_Charging_for_Automotive_2023 Report;

DC Charger Market

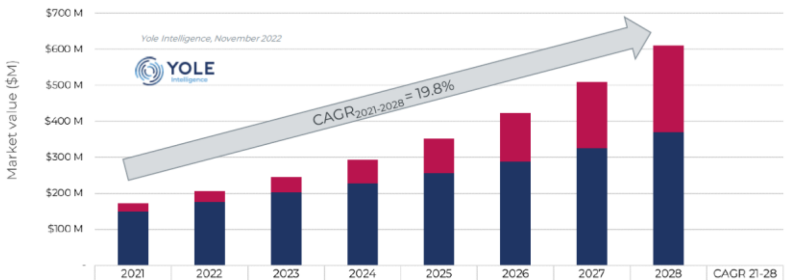
/ Yole DC_Charging_for_Automotive_2023 Report

DC charger system market value in $B, by power category



	2021	2022	2023	2024	2025	2026	2027	2028	CAGR 21-28
200kW ≤ x	$1.2 B	$1.6 B	$2.2 B	$3.0 B	$4.0 B	$5.3 B	$6.9 B	$8.9 B	33.5%
100 < x < 200kW	$1.2 B	$1.7 B	$2.2 B	$2.8 B	$3.4 B	$4.0 B	$4.6 B	$5.2 B	22.6%
50 < x ≤ 100kW	$0.4 B	$0.5 B	$0.6 B	$0.6 B	$0.7 B	$0.8 B	$0.9 B	$1.1 B	14.5%
x ≤ 50kW	$2.4 B	$2.5 B	$2.6 B	$2.7 B	$2.8 B	$2.8 B	$2.8 B	$2.8 B	1.9%
All categories	$5.3 B	$6.3 B	$7.6 B	$9.1 B	$10.9 B	$12.9 B	$15.2 B	$17.9 B	19.1%

Discrete device vs. power module market value in $M



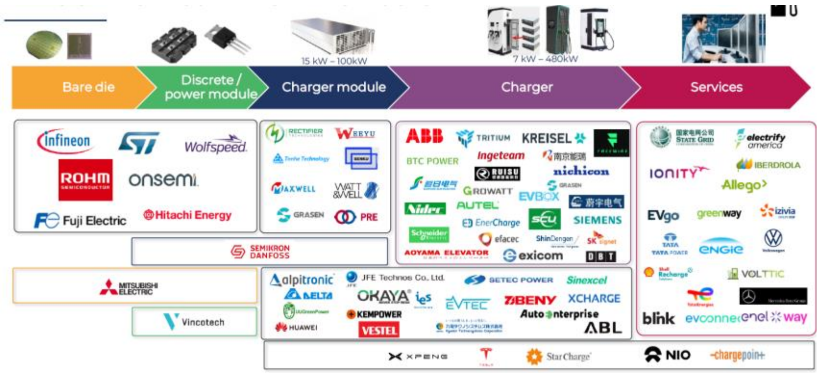
	2021	2022	2023	2024	2025	2026	2027	2028	CAGR 21-28
Module	$22.7 M	$30.6 M	$43.9 M	$65.0 M	$96.0 M	$135.0 M	$182.8 M	$240.9 M	40.1%
Discrete	$149.9 M	$175.8 M	$201.9 M	$228.2 M	$255.5 M	$288.3 M	$326.4 M	$369.8 M	13.8%
All	$172.6 M	$206.3 M	$245.8 M	$293.2 M	$351.5 M	$423.2 M	$509.2 M	$610.8 M	19.8%

- ❑ In 2021, the largest market segment in $M was chargers of 50kW and lower. Nevertheless, the demand for high-power chargers is rapidly growing, with a strong demand for chargers with powers over 100kW. In 2028, the largest market value, $8.9 billion, will be associated with the very high-power (≥200kW) charger market
- ❑ The share of power modules (IGBT and SiC) will increase rabidly in the coming years from 13% in 2021 to 39% in 2028 with a value of $241 million

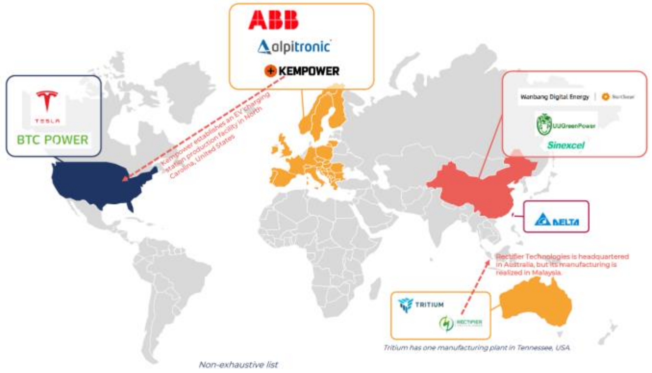
DC Charger Market

/ **Charger supplier**

- Most charger suppliers offer both AC and DC charging solutions
- Depending on the company strategy charger manufacturers make chargers inhouse (chargers based on in-house-made modules or monolithic ones) or use charger modules purchased from external suppliers



/ The market position of the main players for the “new” and rapidly growing DC charger market is continuously evolving and depending on how successful they are in accessing to rapidly-growing geographical markets and in offering high performance, high reliability, and attractive cost.



Yole Status_of_the_Power_Converter_Industry_2023

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DC Charger Trends

DC Charger Trends
DC-Charger Trends and Key Drivers

Even if today and for the future as well the majority of EV will rely on private chargers mainly AC with 7kW, 11kW and 22kW, there will be a growing need for publicly accessible **DC fast chargers** in the next years

- Growing number of electrical vehicle users that can not charge their vehicles at home
- Battery capacity increase that makes overnight charging using low-power AC Chargers no longer suitable

For mid and high power chargers, 30kW up to 350kW, we see trends like:

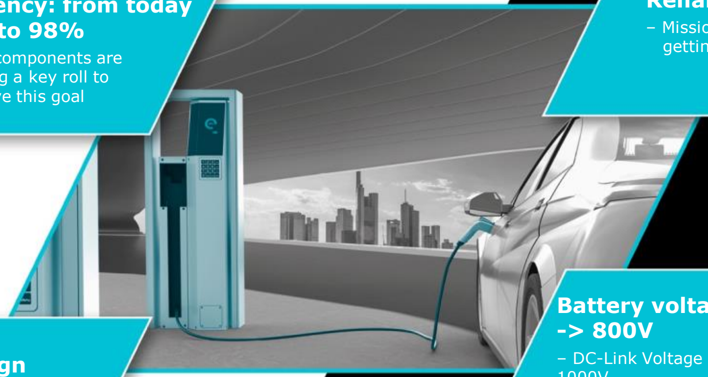
- The **modular design** is dominant over the monolithic design approach thanks to its benefits of high design flexibility and scalability. Typical power ratings for charger modules 30kW and 60kW
- The **power module** solution is preferred rather than the discrete solution with the benefits of optimal thermal management, simplified mechanical assembly, and low parasitic inductance
- **SiC power modules** will gain 35% of the total power module market for EV charging infrastructure by 2025*, and improve the fast-charger efficiency

For **commercial vehicles** like trucks and busses for long-haul trips on the move charging availability of 45min will be needed which will require 500-1200 kW chargers. A new standard will be needed: **MCS**

Bi-directional charging
- Not yet a global trend
- V2L, V2G or V2H

Efficiency: from today 95% to 98%
- WBG components are playing a key roll to achieve this goal

Reliability
- Mission profiles are getting harder



Battery voltage 400V -> 800V
- DC-Link Voltage from 500V to 1000V
- Wide DC output voltage range (200V->920V)

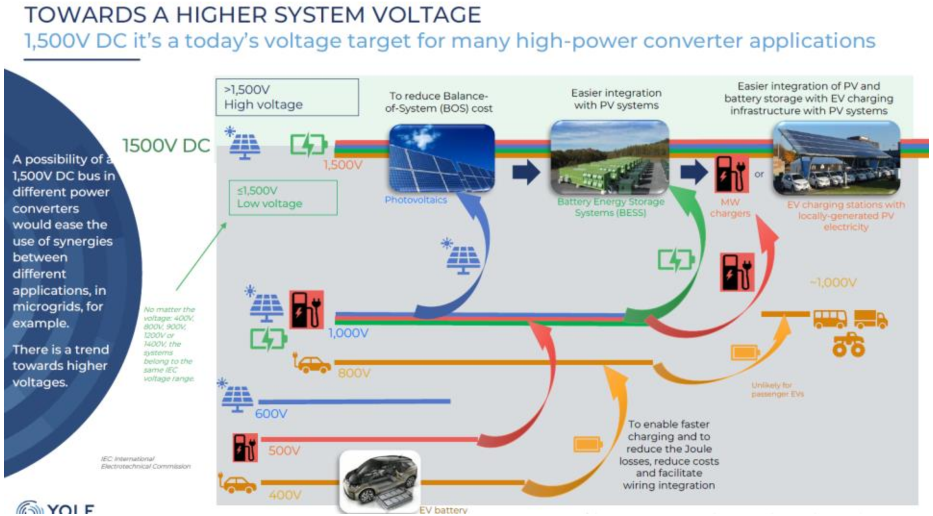
Modular design
- In the modular approach, a charger is built of several charger stacks connected in parallel

High power charging stations
- Fast charging
- Public charging and workplace charging
- Destination charging

*Yole report "Power_SiC_2022_report"

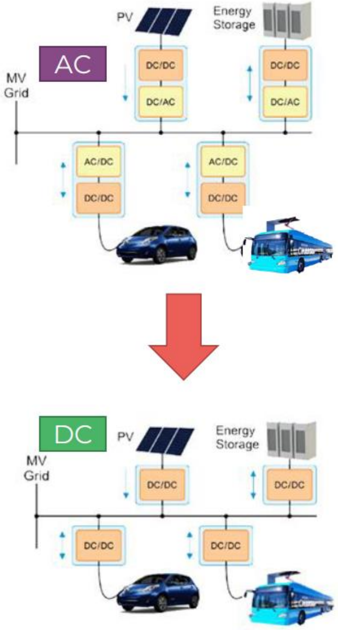
DC Charger Trends
DC-Charger Trends and Key Drivers

Trend towards higher system voltage, e.g. to Mega Watt Charger requirements



Trend towards Microgrids: Design common high-voltage DC bus at voltage suitable for different applications.

DC bus can be designed at 500V, 1000V, 1500V or another suitable voltage level



Consumers are interested in combining their EV with home energy management systems

*Yole report "Status_of_the_Power_Converter_Industry_2023"

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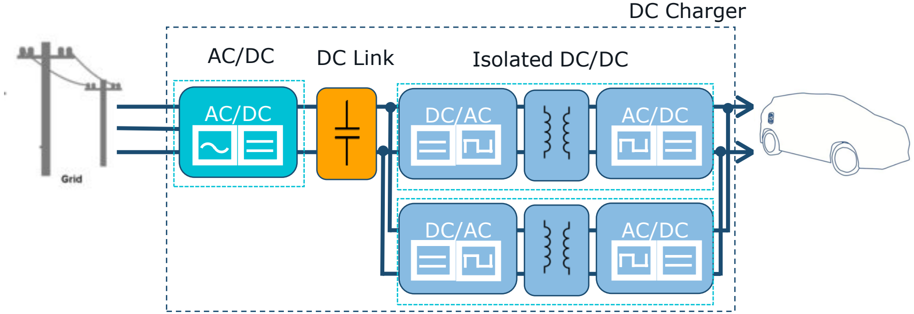
DC Charger System Architectures

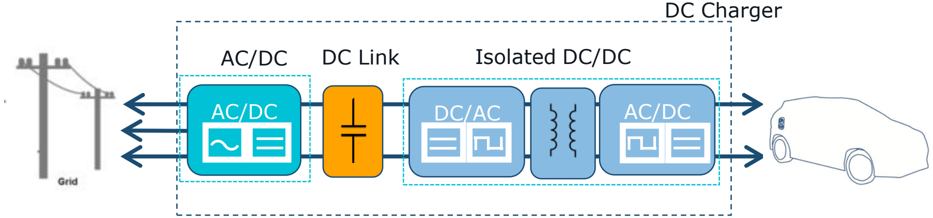
DC Charger System Architectures

System Architecture 1: This is the **state-of-the-art system architecture** for DC Charger 10kW up to 350kW. Depending on output power, this can be a system built from one or more charger modules. Supply is taken from low-voltage 3-phase grid.

In some designs, the **DC/DC stage is split in 2.** These parts can be connected in series or parallel. This is done in order to coupe with the available **battery voltages: 400V and 800V**

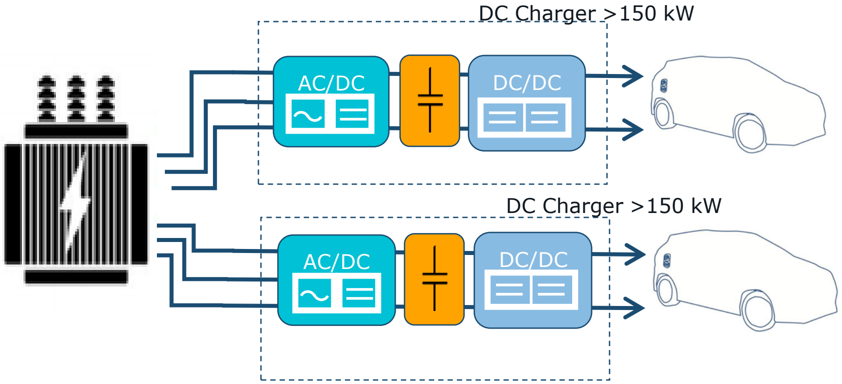


System Architecture 2: The same as system architecture 1 but **bi-directional**. It is mainly designed for V2x applications



DC Charger System Architectures

System Architecture 3: Design aimed to serve the higher power (>150 kW) market, e.g. charging parks. A medium-voltage transformer furnishes power directly to the system. Separated windings per charger needed on the secondary side of transformer. The advantages of this system architecture are system costs and efficiency



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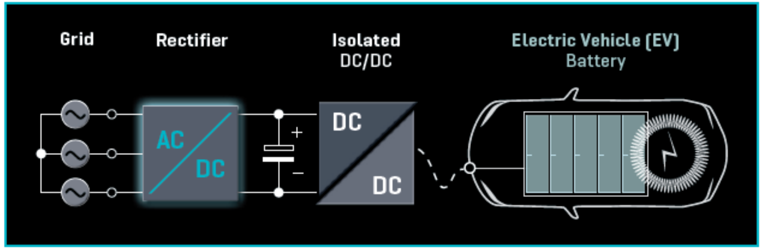
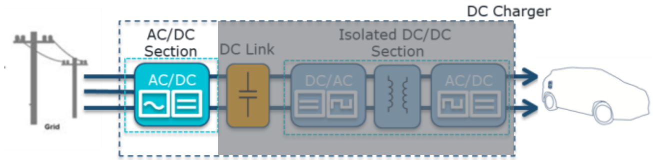
DC Charger System Architectures

AC/DC



DC Charger System Architectures
AC/DC



/ There are several three-phase PFC topologies available which can be addressed with multiple 3L and 2L topologies with pros and cons in terms of efficiency, costs and design complexity

/ Each of these topologies will influence
- the blocking voltage rating of the semiconductors e.g. 650 V or 1200 V and as a result, the switching losses and the efficiency

- the total system costs, e.g. PFC inductor size and costs
  - At a given frequency the current ripple at 2L is twice as high as in 3L applications which has an impact on the inductor core material and size

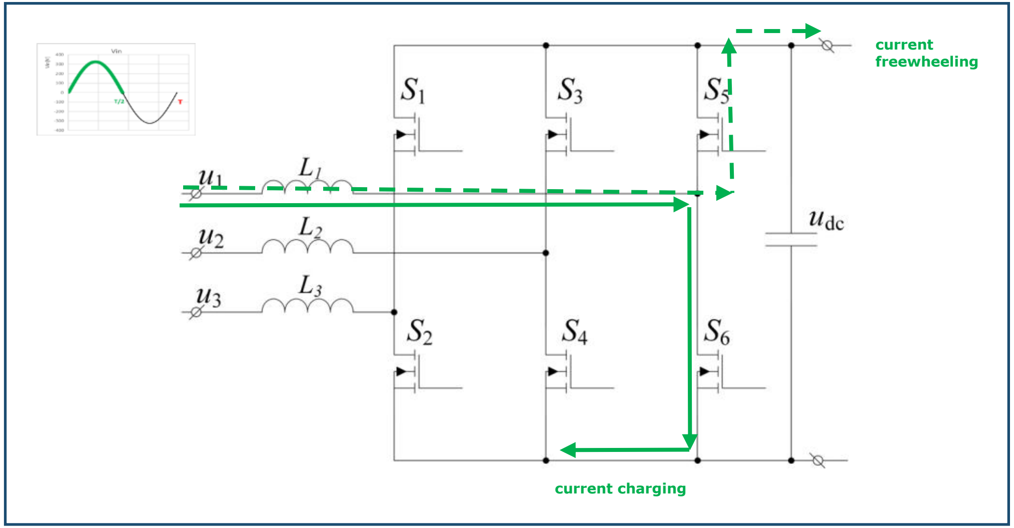
- the thermal management, e.g. heat sink size

- the design e.g. uni- or bi-directional. For **bi-directiona**l charging the 3L SPFC and NPFC are suitable by replacing the boost diodes with switches, and the 2L 6pack per se

DC Charger System Architectures
AC/DC

2L three-phase PFC topologies: The most common used 2L PFC topology is 6PACK PFC - Active Front End (AFE)

- It is the simplest topology and widely used in motion control as a motor inverter. It can be used as PFC in reverse mode
- All switches are 1200V rated which has an impact on the losses. On the other hand only one switch per phase is involved in the power flow at any time
- The control is straight-forward
- Bidirectional by nature



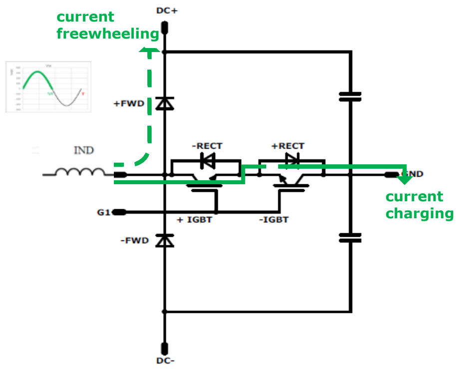
DC Charger System Architectures
AC/DC

3L three-phase PFC topologies: Wide range of choice among different 3L PFC topologies

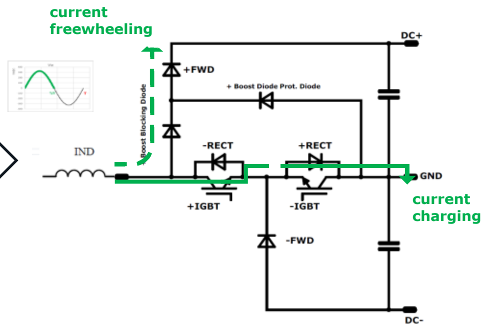
Neutral Boost PFC (**NPFC**, or T-Type)
- NPFC uses back-to-back switches, having the same emitter and thus needs only single gate driver
- The switches are 650V rated and the boost diodes 1200V
- The conduction losses are low, as only one component at a time is in series in the current path

Advanced Neutral Boost PFC (**ANPFC**)*
- ANPFC is a modified NPFC with 650V rated boost diodes
- Two components are always in series in the current path, thus higher conduction losses than NPFC
- Less costs for the 650V devices vs the 1200V devices

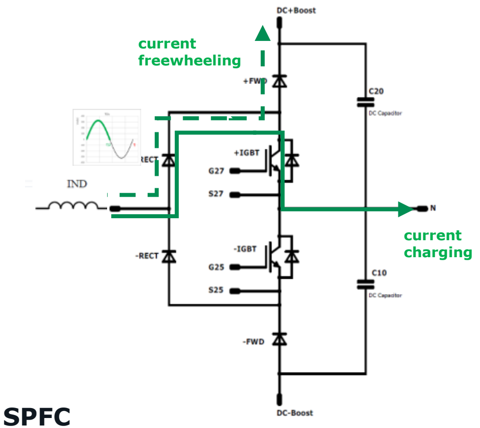
Symmetric Boost PFC **(SPFC,** or I-Type)
- Switches and Diodes are 650V rated
- Two components are always in series in the current path, thus higher conduction losses than NPFC
- Needs separate gate drive for the LS and HS switch



NPFC



ANPFC *Proprietary topology from Vincotech

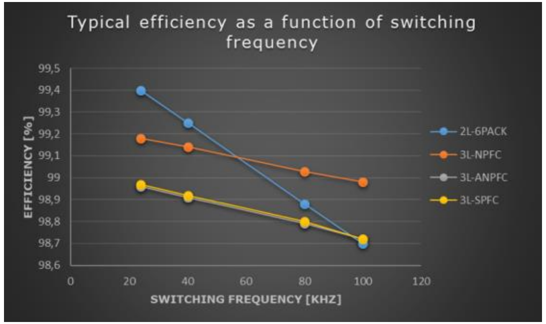


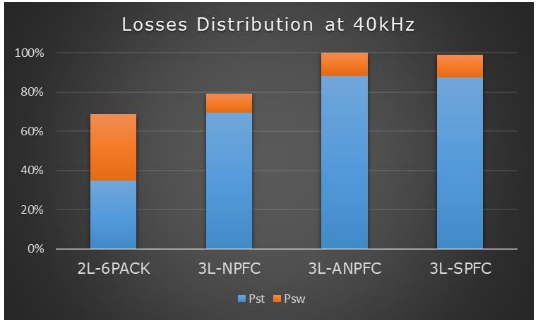
SPFC

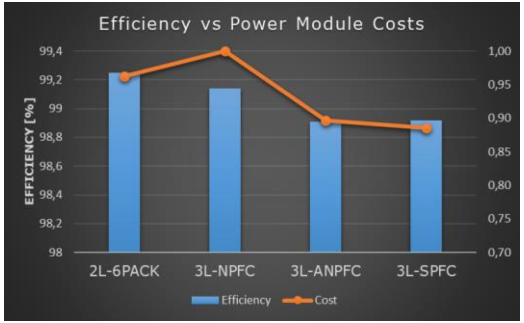
DC Charger System Architectures
AC/DC

Benchmark of 2L vs 3L in terms of **efficiency and power module costs**

- 30 kW Charger unit (Vin 230A, DC Link 800V, Ths 80°C, **Tjmax <130°C**)
- Similar chip technology for the main devices
  - 2L-6PACK: 1200V/16mOhm SiC MOSFET
  - 3L-NPFC: 650V/22,5mOhm SiC MOSFET and 1200V/60A SiC Diode
  - 3L-ANPFC and –SPFC: 650V/22,5mOhm SiC MOSFET and 650V/60A SiC Diode





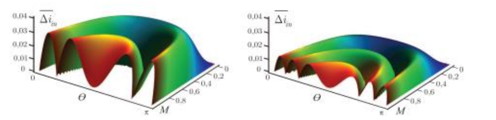


- 2L-6PACK is showing the best efficiency for fsw up to 60kHz, but has also high costs. The switching losses are limiting the efficiency at high switching frequencies
- NPFC has high efficiency also for higher fsw but with the drawback of higher costs because of the 1200V diodes
- ANPFC and SPFC are showing same efficiency, but ANPFC with single gate drive has a total cost advantage vs SPFC

DC Charger System Architectures
AC/DC

Benchmark of 2L vs 3L in terms of inductor size and total costs

- PFC Inductor cost depends on the size and the required core material
- Core material suitable for higher ripple and frequency leads to higher cost and bigger size



Inductor current ripple for **2L and 3L** PFC

Compact size efficient charger solution could be:

- Inductor core material is given (e.g. Ferrite core) ➔ Inductor size and cost can be reduced
- Efficiency target: 99%

	2L ➔	3L
Inductor size and costs	100%	50%
Switching frequency	100% e.g. 50kHz	200% e.g. 100kHz ↓
Inductor size and costs	100%	**25%**

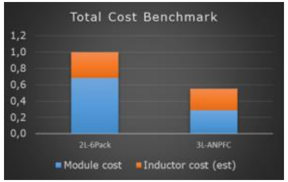
- ✓ 2L-6PACK: 1200V SiC MOSFET
- ✓ 3L-NPFC: 650V SiC MOSFET and 1200V SiC Boost Diodes

Cost effective charger solution could be:

- Inductor size is given ➔ Module price and Inductor core material price can be slightly reduced (soft iron powder core)
- Efficiency target: 99%

	2L ➔	3L
Switching frequency	100% e.g. 50kHz	50% e.g. 20kHz
Inductor core material (price)	100%	**~90%**
Semiconductor (price)	100%	**60%**

- ✓ 2L-6PACK: 1200V SiC MOSFET
- ✓ 3L-ANPFC: 650V fast IGBT and 650V fast Boost Diodes



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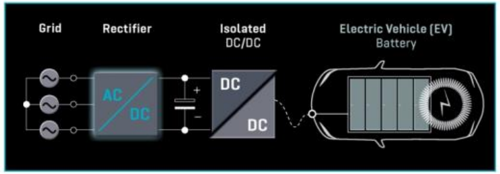
The table summarizes the pros and cons of each topology discussed in this presentation

	AFE (6PACK)	NPFC	ANPFC	SPFC
Switching levels	2L	3L	3L	3L
Main Switch Voltage [V]	1200	650	650	650
Main Diode Voltage [V]	1200	1200	650	650
Number of devices per phase (fast switches , fast diodes, rectifier diodes, protection diodes)	4	6	8	8
Gate drives / per phase	2	1	1	2
Bidirectional	Yes / no extra cost	Yes / with additional components => extra cost	Yes / with additional components => extra cost	Yes / with additional components => extra cost
Efficiency	>99% (up to fsw 60kHz)	>99% (up to fsw 100kHz)	>98,7% (up to fsw 100kHz)	>98,7% (up to fsw 100kHz)
Overall BOM costs / total cost	High / High	High / Low	Low / Low+	Low / Low

These values are subject to change in particular applications

Conclusion:



- ✓ The AC/DC stage of a DC fast charger can be addressed with several three-phase PFC topologies
- ✓ Depending on the application requirements the pros and cons of the multiple designs have to be considered
- ✓ In practice, the **3L three-phase PFC** topologies combined with **SiC chip technology** show the best trade-off between efficiency and overall total system costs

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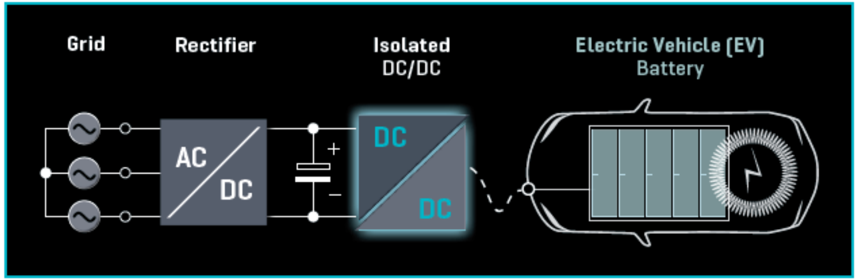
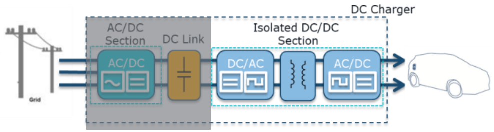
DC Charger System Architectures

DC/DC



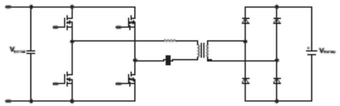
DC Charger System Architectures
DC/DC



- For the DC-DC power conversion stage two main isolated topologies are employed: the full-bridge LLC resonant converter, and the full-bridge phase-shift DAB. The first one is a pure frequency modulated configuration and the second operates with PWM

- The full-bridge LLC converter with full bridge rectifier is on of the most used configuration for unidirectional charging. Main benefits
  - Reduce switching losses
  - Increase efficiency
  - Galvanic isolation
- It is a soft switching topology (ZVS, ZCS) resulting in a very high peak efficiency around the resonant frequency
- Multiple variants can be used for primary and secondary side with additional advantages and compromises
- For **bi-directiona**l charging the full bridge rectifier on the secondary side has to be replaced with a full bridge

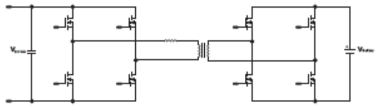
LLC



Product line Full-bridge
***fast*PACK SiC**

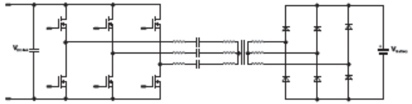
Product line
Ultrafast Rectifier
***fast*PACK SiC**

DAB



Product line Full-bridge
***fast*PACK SiC**

Three-Phase LLC

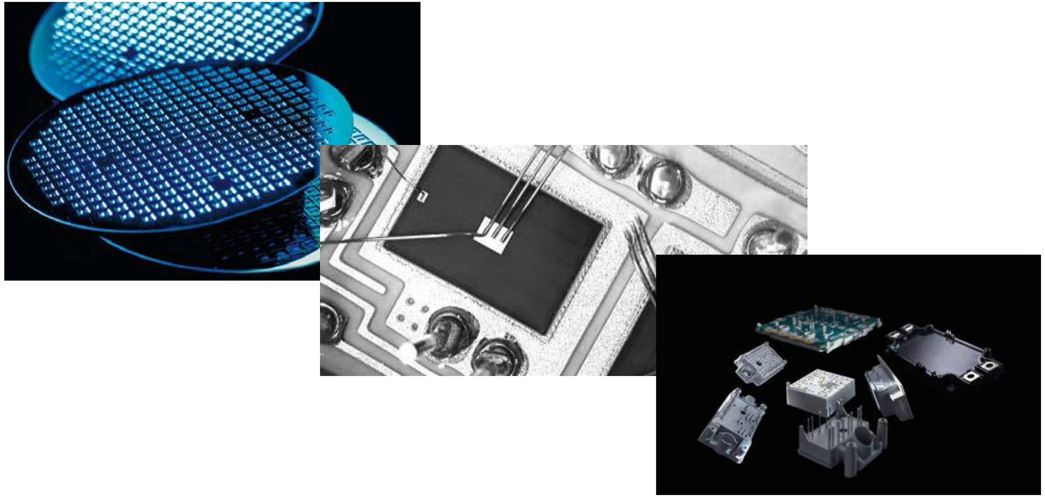


Product line 6Pack
***flow*PACK SiC**

New Product line
Ultrafast Rectifier
***flow*CON SiC**

VIN DC Charger Product Solutions

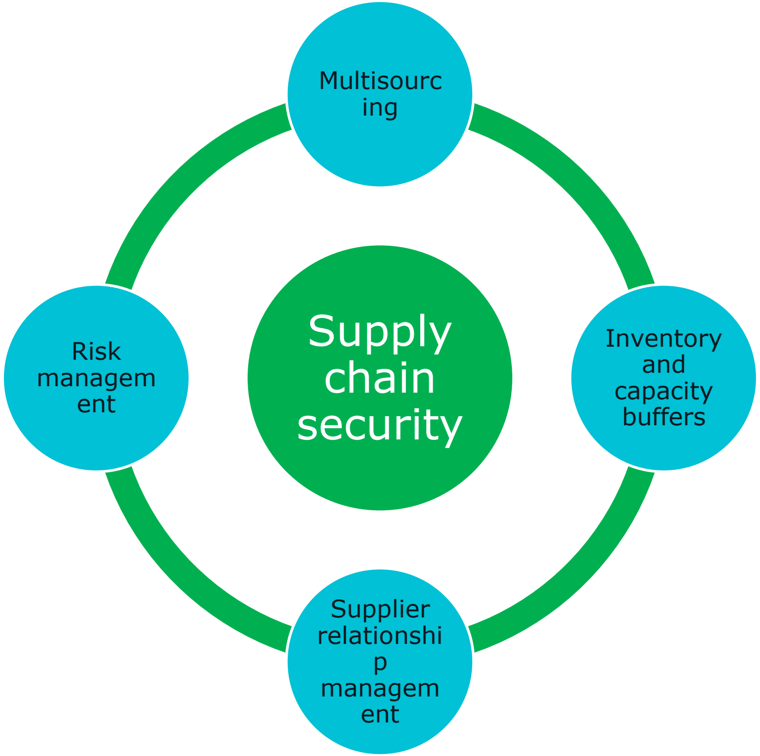
SiC Device and Housing Technologies



SiC Device and Package Technologies

By having multiple semiconductor sources Vincotech can offer a price and performance optimized power module. With its open & flexible vendor policy Vincotech provides the widest range of chip suppliers. VINcoSIM, the simulation tool with characterized switching pairs, supports fast and easy selection of the most fitting power module.

Vincotech follows a multi-source approach and strives to have at least two qualified sources wherever possible. Power semiconductors from a variety of manufacturers can be offered, and customers are recommended to release minimum two independent chipsets to secure long-term supply. Own inventory and capacity buffers provide flexibility and security. A strong supplier relationship management provides close collaboration and clear communication. Additionally a systematic risk management ensures early detection and mitigation of any supply issue.



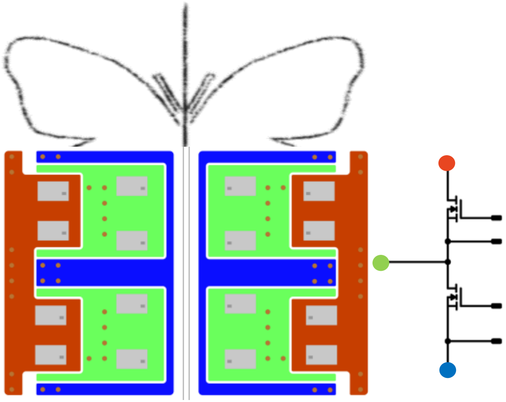
SiC Device and Package Technologies

/ Deep SiC device performance understanding

- Increasing number of players that provide power SiC devices with different device structures (e.g. planar, trench) and specification (e.g. voltage class, V_{GS})
- The selection of the optimal SiC device for a specific application requires a deep understanding of characteristic figures like static and dynamic losses on module level

/ Optimal layout design and pin arrangement

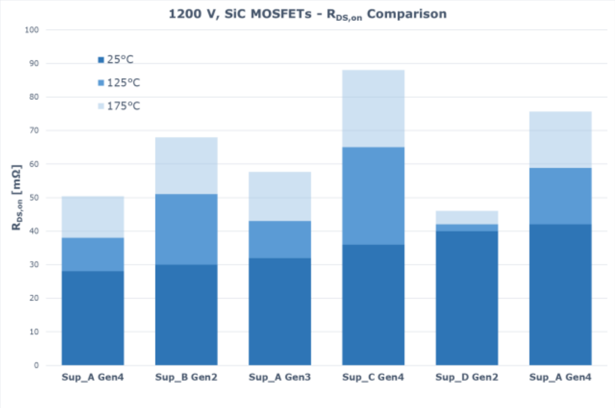
- A high power SiC module requires a large number of chips in parallel which makes the design and layout challenging
- The design of a very symmetrical chip layout impacts positively the total module efficiency



/ **Why SiC Power Module Reliability Matters** Increasing number of players that provide power SiC devices with different device

SiC Device and Package Technologies

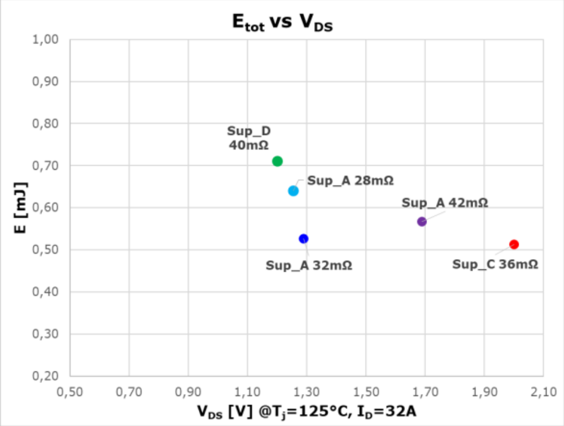
$R_{ds,on}$ Temperature dependency



- / SiC MOSFET have a positive temperature coefficient. The knowledge of the $R_{ds,on}$ at operating temperature, such 125° C is key
- / There is a huge variation among the different SiC device regarding the dependency of $R_{ds,on}$ vs. the temperature
- / SiC supplier D is showing the best-in-class $R_{ds,on}$ temperature dependency, which is a good fit for soft-switching applications where static losses dominate. Also suitable for hard-switching applications switching at lower frequencies

Trade-off between conduction and switching losses

Measurement at same conditions:
VDS=600V,
recommended VGS,
Rg,ext=4Ohm,
Tj=125°C

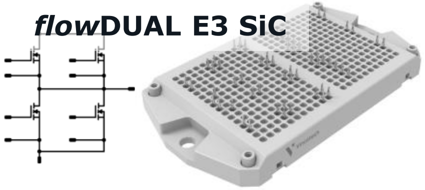


- / Static losses are just the one side of the coin. For optimal selection you need also the knowledge of the dynamic losses
- / Also in this case the trade-off between conduction and switching losses varies from SiC supplier and the used technology
- / SiC supplier A offer the best compromise between switching and conduction losses and SiC supplier C has the lowest switching losses at nominal current, or at partial load

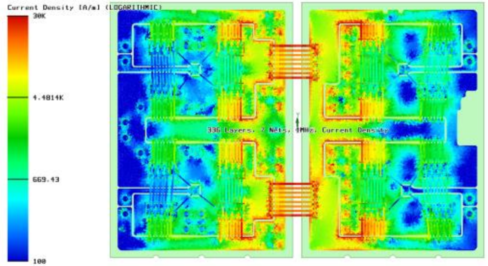
SiC Device and Package Technologies

Test vehicle

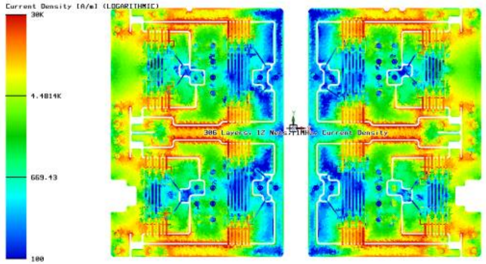
***flow*DUAL E3 SiC**



Current density simulation

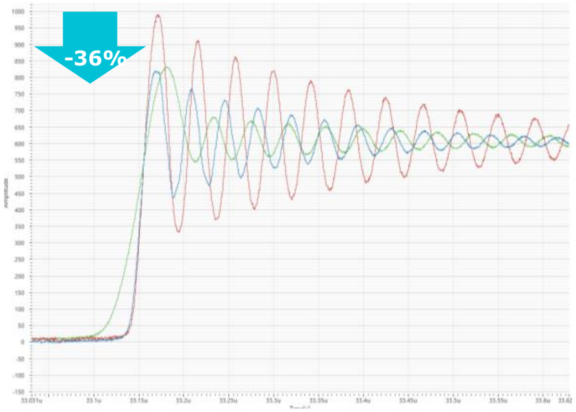


- Standard layout/pinout design
- Loop inductance **4,343 nH**@100 kHz



- Optimized layout/pinout design
- Loop inductance **1,64 nH**@100 kHz

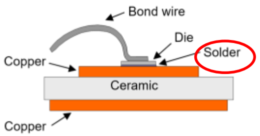
Vds Overshoot at turn-off



- Less overshoot → lower Rg can be used → Less losses
- Less overshoot → same Rg can be used → more margin to breakdown

SiC Device and Package Technologies

/Why do the SiC chip solder joint face higher stress than a Si while a power cycling load?



Higher stress on the chip solder during temperature stress

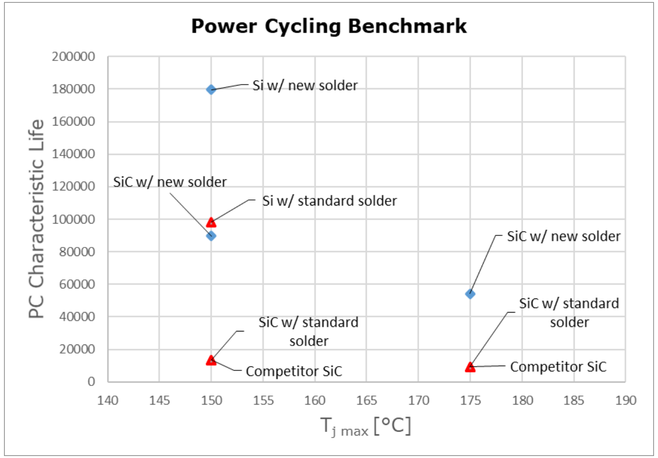
a) Contrary to the superior electrical properties of SiC, the mechanical properties, specifically the **Youngs Modulus**, have an negative impact on the **power cycling capability**

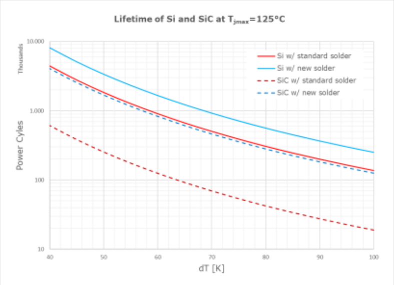
b) On top, additional stress will applied on the **solder joints** because

- Smaller chip size
- Mission profiles with long period of max power, like in the case of EV charger
- High chip temperatures together with high current

➔ **Reinforcement of the chip solder** joint is crucial to improve the power cycling capability

With the introduction of a new solder alloy the SiC power cycling capability was pushed close to a level of cycling capability just like Si (with standard solder)





Assuming a charger mission profile with 24 cycles/day, constant dT of 100K and Tjmax 125°C, the estimated life time of a SiC power module would be ~15 years

SiC Device and Package Technologies

Vincotech has extended its portfolio of **baseplate-less, 12-mm, low-inductive power modules** with two new housings. The new *flow* E3 modules bring the benefits of industry- standard *flow* E housings to the higher power range and help engineers to extend their current designs to higher power levels while keeping mechanical changes small.

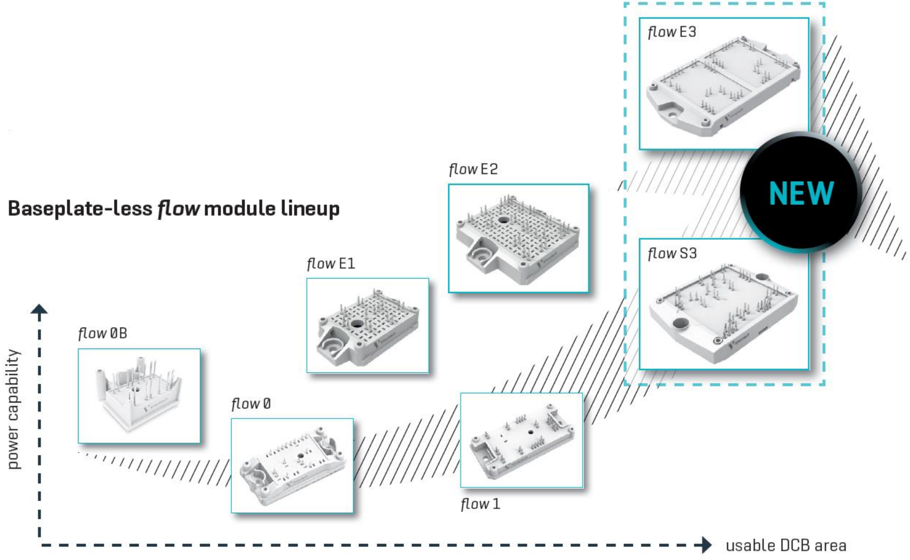
Additionally the *flow* S3 and *flow* E3 modules feature VINcoPress and advanced die-attach technologies. Both provide the widely valued pre-applied phase-change thermal interface material (PC-TIM), the choice between solder or press-fit pins and optional AlN I

Housing Features

- VINcoPress technology
- Advanced die-attach technology
- Al_2O_3 and AlN DCB available
- Low inductive, 12mm housing
- Pre-applied PC-TIM rated for 150°C
- Press-fit and solder pin

Application Benefits

- Longer lifetime, greater reliability
- Increased power density
- Simple, economical module mounting



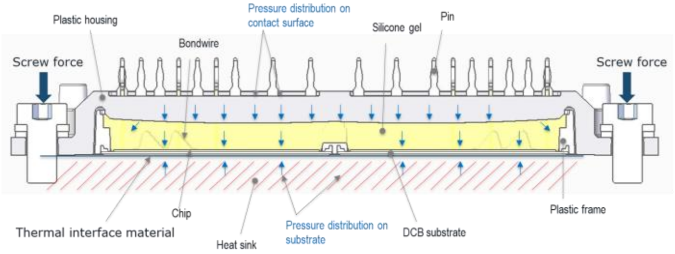
The VINcoPress technology is aiming for **superior thermal performance with improved reliability**. The novel power module packaging technology presses the entire substrate to the heatsink, directly and evenly. It distributes pressure uniformly avoiding uncontrolled force to the substrate and eliminates the cracking risk during assembly.

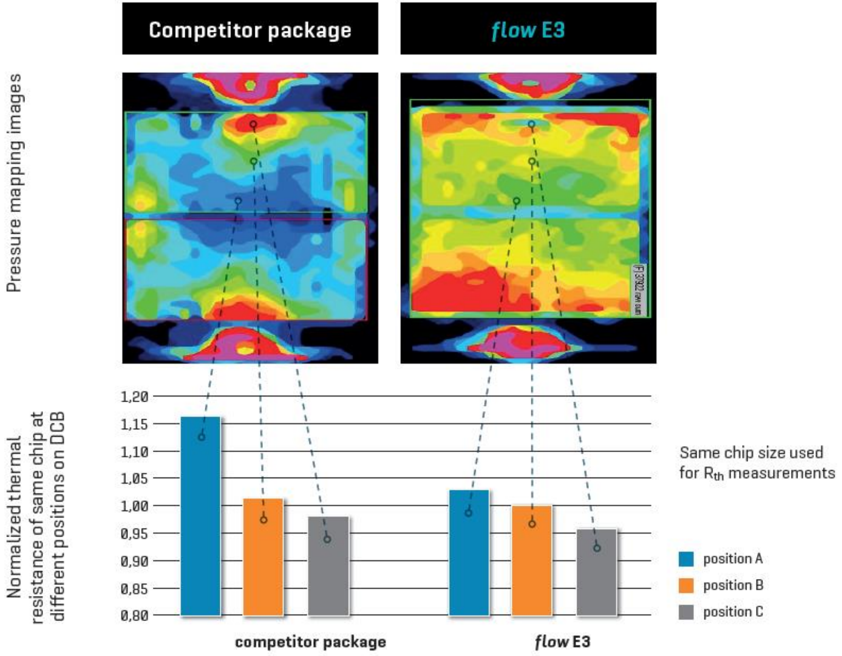
Key Features

- Direct pressed substrate
- Homogeneous pressure and R_{th} value distribution
- Rugged and reliable heat sink assembly

Benefits

- Higher power capability
- Greater power density





SiC Device and Package Technologies

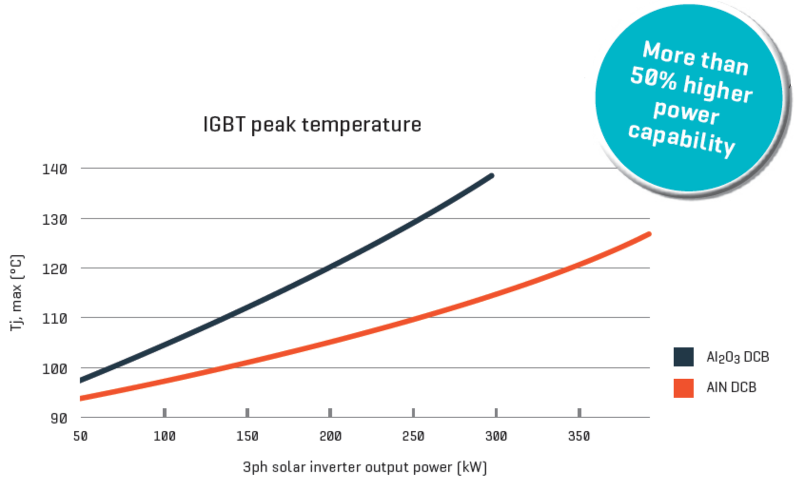
It takes ceramic materials with higher thermal conductivity to boost baseplate-less power modules' current-carrying capability. Aluminum Nitride (AlN) can reduce the **thermal resistance** from semiconductor junction to heatsink while the VINcoPress technology maintains rugged and reliable heat sink assembly.

VINcoSIM, our integrated simulation environment, served to benchmark AlN DCB's peak junction temperature in comparison with Al_2O_3 using a 3-level NPC (I-type) module for a solar inverter application. It confirmed that AlN increases power capability by more than 50% at the same junction temperature.

Key Features

- Increases power modules' current carrying capability
- Delivers superior thermal performance
- Decreases the thermal expansion coefficient

- **Benefits**
- Up to 50% more power from the same power module foot print
- Better performance from the same frame size

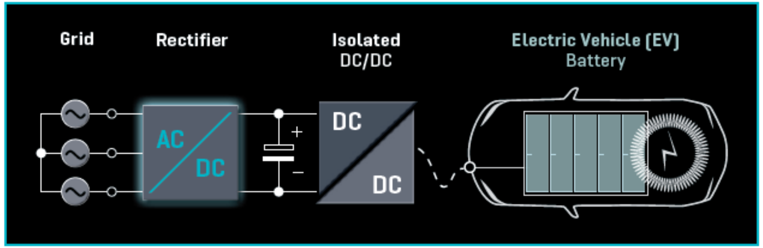


Conditions: V_{dc} = 1350 V, V_{ac} = 460 V, cosphi = 0.8, f_{sw} = 16 kHz, T_{hs} = 90°C, $R_{g,on}$ = $R_{g,off}$ = 2Ω

VIN DC Charger Product Solutions

DC Charger Product Roadmap

AC/DC



DC Charger Product Roadmap

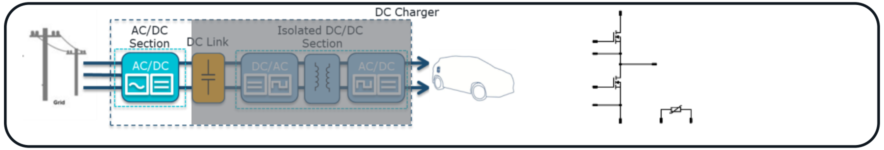
Comprehensive 2L and 3L PFC Portfolio for the AC/DC stage

Housing	Half-bridge	6PACK
flow 1		-1200V/75mOhm-16mOhm SiC MOSFET -Up to 30kW application power
flow S3	-1200V/3mOhm, SiC MOSFET* -Up to 120kW application power	
flow E1	-1200V/32mOhm,21mOhm,18mOhm,16mOhm SiC MOSFET -Up to 40kW application power	-1200V/75mOhm,32mOhm SiC MOSFET -Up to 20kW application power
flow E2	-1200V/8mOhm,5mOhm SiC MOSFET -Up to 75kW application power	-1200V/20mOhm,11mOhm SiC MOSFET -Up to 35kW application power
flow E3	-1200V/2mOhm SiC MOSFET -Up to 150kW application power	

Housing	NPFC/MNPC	ANPFC	SPFC
flow 0	-650V/75A,100A IGBT H5, with 1200V fast Si Diode or SiC SBD -650V/45mOhm SiC MOSFET -Up to 30kW application power	-650V/100A IGBT fast, with 1200V fast Si Diode or SiC SBD -Up to 30kW application power	-650V/50A,75A,100A IGBT H5/S5, with 1200V fast Si Diode -Up to 22kW application power
flow 1	-650V/100A IGBT S5, with 1200V SiC SBD -650V/15mOhm SiC MOSFET -Up to 60kW application power	-650V/100A IGBT fast/S5 with 1200V SiC SBD -650V/15mOhm SiC MOSFET* -Up to 50kW application power	-650V/15mOhm SiC MOSFET* -Up to 50kW application power
flow E2	-650V/15mOhm SiC MOSFET -1200V/11mOhm SiC MOSFET -Up to 60kW application power		
flow E3	-3xNPFC/MNPC 650V/15mOhm* -Up to 50kW application power		

*Assuming a typical charging operation point: Vin 230V, Vdc 800V, fsw 40kHz, Ths 80°C

DC Charger Product Roadmap



*Assuming a typical charging operation point: Vin 230V, Vdc 800V, fsw 40kHz, Ths 80°C

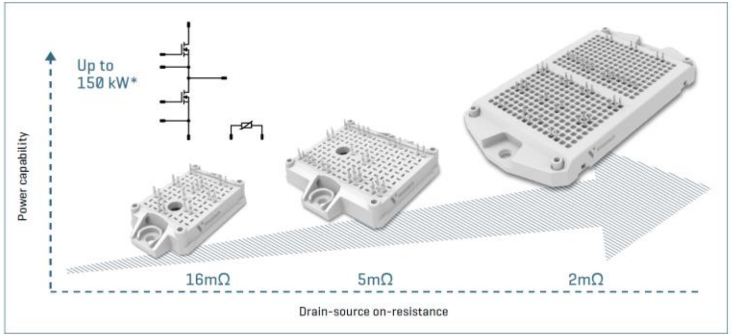
Voltage	Product Line	Technology SiC Inside	Part Number	Product Family	RDSon [mOhm]								Application Power rating*	2023				2024				2025			
					2	3	5	8	16	18	21	32		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1200V	flowDUAL E1 SiC	SiC MOSFET Gen3	10-EZ122PB032ME-PE07F18T	PE0x									up to 22 kW												
		SiC MOSFET Gen3	10-EZ122PA021ME-LJ6x	LJ6x									up to 30 kW												
		SiC MOSFET Gen4	10-EZ122PA018MR-LJ6x										up to 30 kW												
		SiC MOSFET Gen3	10-EZ122PA016ME-LJ67F68T										up to 40 kW												
	flowDUAL E2 SiC	SiC MOSFET Gen3	10-EY122PA008ME-LU38F08T 10-EY122PA005ME-LU39F08T	LU3x									up to 60 kW up to 80 kW												
			10-EY122PA008ME01-LU38F06T										up to 75 kW												
	flowDUAL S3 SiC	SiC MOSFET Gen3/Gen4	B0-SP122PA003ME B0-SP122PA003MR	LM7x									up to 120 kW												
	flowDUAL E3 SiC	SiC MOSFET Gen3	B0-EP122PA002ME-PG88F18T	PG8x									up to 150 kW												

Ongoing R&D Project

Product Concept

Serial Status

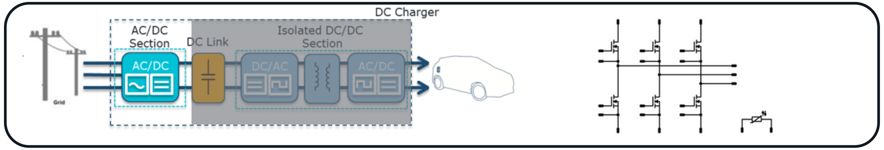
- Engineered to bring **maximum power density** and **greater**
- **scalability** to H-bridges and sixpacks
  Greater **supply chain resilience** with industry-standard housings (CTI >600)
- **VINcoPress tech** (for *flow* E3)
- Advanced **AlN** substrate



Outlook

- Concepts ongoing for flowDUAL E3/E3 SiC with **2xkV SiC MOSFET** Tech
- Target applications 1500Vdc, like MCS

DC Charger Product Roadmap

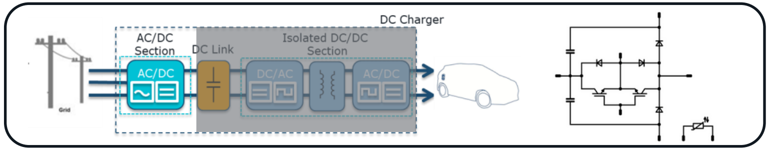


*Assuming a typical charging operation point: Vin 230V, Vdc 800V, fsw 40kHz, Ths 80°C

Voltage	Product Line	Technology SiC Inside	Part Number	Product Family	R_{DSon} [mOhm] 11	16	18	20	32	36	40	75	Application Power rating*	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4	2025 Q1	2025 Q2	2025 Q3	2025 Q4
1200V	flowPACK E1 SiC	SiC MOSFET Gen3	10-EZ126PB075ME-LS17F08T 10-EZ126PB032ME-LS18F08T	LS1x					green			blue	up to 11 kW up to 20 kW	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
1200V	flowPACK E2 SiC	SiC MOSFET Gen3	10-EY126PB021ME-PJ17F18T 10-EY126PB011ME-PJ19F18T	PJ1x	green			green					up to 25 kW up to 35 kW	yellow	green	green	green	green	green	blue	blue	blue	blue	blue	blue
1200V	flowPACK E2 SiC	SiC MOSFET Gen1	10-EY126PB020MS02-PJ17F78T	PJ1x				green					up to 25 kW	yellow	green	green	green	green	green	blue	blue	blue	blue	blue	blue
1200V	flowPACK 1 SiC	SiC MOSFET Gen1	10-PY126PA020MS-L227F08Y	L22x				green					up to 25 kW	yellow	green	green	green	green	blue	blue	blue	blue	blue	blue	blue
1200V	flowPACK 1 SiC	SiC MOSFET Gen3	10-FY126PA032ME-L226F13 10-PY126PA016ME-L227F13Y	L22x		blue			blue				up to 22 kW up to 30 kW	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
1200V	flowPACK 1 SiC	SiC MOSFET Gen4	10-PY126PA036MR-L22x 10-PY126PA018MR-L22x	L22x			orange			orange			up to 22 kW up to 30 kW	orange	orange	orange	orange	orange	orange	orange	orange	orange	orange	orange	orange
1200V	flowPACK 1 SiC	SiC MOSFET Gen4	10-FY126PA042ME-L226F68 10-FY126PA021ME-L227F68	L22x				green			green		up to 20 kW up to 25 kW	orange	green	green	green	green	green	blue	blue	blue	blue	blue	blue
900V	flowPACK 1 SiC	SiC MOSFET Gen3	10-PY096PA035ME-L224F18Y	L22x					blue				up to 22 kW	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
650V	flowPACK 1 SiC	SiC MOSFET Gen4	10-FY086PA023MR-L222F48	L22x				green					up to 25 kW	orange	orange	green	green	green	green	blue	blue	blue	blue	blue	blue

Ongoing R&D Project (green)
Product Concept (orange)
Serial Status (blue)

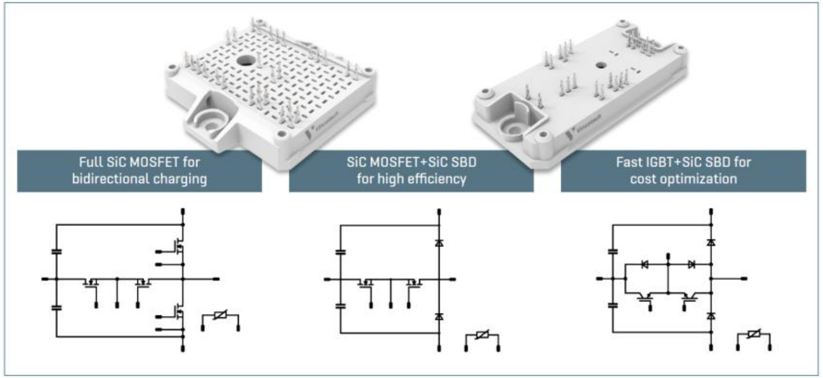
DC Charger Product Roadmap



*Assuming a typical charging operation point: Vin 230V, Vdc 800V, fsw 40kHz, Ths 80°C

Voltage	Product Line	Technology SiC Inside	Product Family	Part Number	RDSon [mOhm]			Application Power rating*	2023				2024				2025			
					11	15	45		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1200V	flowMNPC E2 SiC	full SiC-MOSFET	LS2x	10-EY12NMA011ME30-LS28F18T				Up to 60 kW												
650V	flowMNPC E2 SiC	full SiC-MOSFET	LS2x	10-EY12NMA016ME-LS28F16T				Up to 50 kW												
650V	flowMNPC 1 SiC	full SiC-MOSFET	PG0x	10-PY12NMD016ME-PG08F18T				Up to 50 kW												
650V	flowMNPC 0 SiC	full SiC-MOSFET	M26x	10-FZ12NMA032ME				Up to 30 kW												
650V	flow3xMNPC E3 SiC	full SiC-MOSFET	PH0x	B0-EP12M3A015ME				Up to 50 kW												
650V	flowNPFC 0 SiC	SiC MOSFET/SiC SBD	M26x	10-FZ07LBA045ME				Up to 30 kW												
650V	flowNPFC 1 SiC	SiC MOSFET/SiC SBD	PG0x	10-PY07LBA015ME-PG08J68T				Up to 60 kW												
650V	flow3xNPFC E3 SiC	SiC MOSFET/SiC SBD	PH0x	B0-EP12L3A015ME				Up to 50 kW												

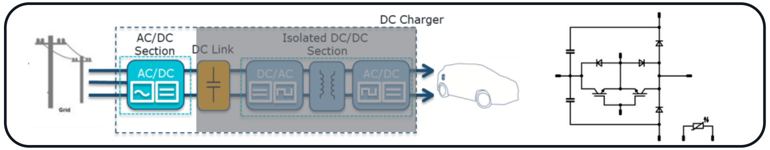
Ongoing R&D Project
Product Concept
Serial Status



New Optimized Pin-out Features

- Shorter DC+ to GND and DC- to GND distance
- Lower stray inductance
- Optimal commutation loops
- Symmetrical and short commutation loops with
- balanced operation in pos and neg half period
- Symmetrical gate commutation loops
- Easy to add separated gate resistance

DC Charger Product Roadmap



*Assuming a typical charging operation point: Vin 230V, Vdc 800V, fsw 40kHz, Ths 80°C

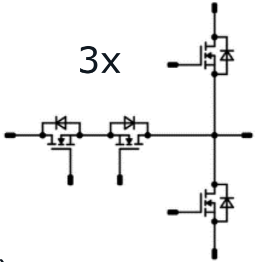
Voltage	Product Line	Technology SiC Inside	Product Family	Part Number	RDSon [mOhm] 11	RDSon [mOhm] 15	RDSon [mOhm] 45	Application Power rating*	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4	2025 Q1	2025 Q2	2025 Q3	2025 Q4
1200V	flowMNPC E2 SiC	full SiC-MOSFET	LS2x	10-EY12NMA011ME30-LS28F18T				Up to 60 kW												
65[illegible]	flowMNPC E2 SiC	full SiC-MOSFET		10-EY12NMA016ME-LS28F16T				Up to 50 kW												
	flowMNPC 1 SiC	full SiC-MOSFET	PG0x	10-PY12NMD016ME-PG08F18T				Up to 50 kW												
	flowMNPC 0 SiC	full SiC-MOSFET	M26x	10-FZ12NMA032ME				Up to 30 kW												
	flow3xMNPC E3 SiC	full SiC-MOSFET	PH0x	B0-EP12M3A015ME				Up to 50 kW												
	flowNPFC 0 SiC	SiC MOSFET/SiC SBD	M26x	10-FZ07LBA045ME				Up to 30 kW												
	flowNPFC 1 SiC	SiC MOSFET/SiC SBD	PG0x	10-PY07LBA015ME-PG08J68T				Up to 60 kW												
	flow3xNPFC E3 SiC	SiC MOSFET/SiC SBD	PH0x	B0-EP12L3A015ME				Up to 50 kW												

Ongoing R&D Project

Product Concept

Serial Status

flow3xMNPC E3 SiC (PH0x)

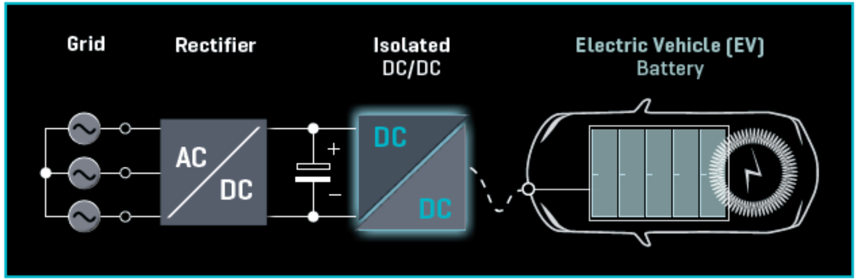


Application: Bi-directional
Topology: 3xMNPC
PFC switch_NP: 650V SiC MOSFET
PFC switch_DC: 1200V SiC MOSFET
Housing: flow E3
Features: DClink caps and gate resistors optional

VIN DC Charger Product Solutions

DC Charger Product Roadmap

DC/DC

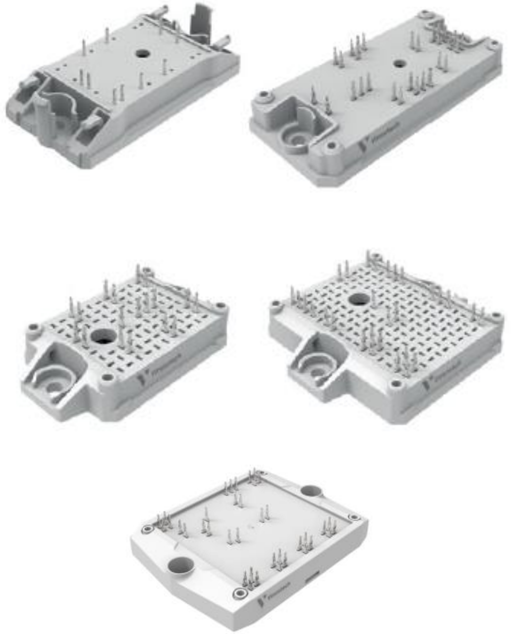


DC Charger Product Roadmap

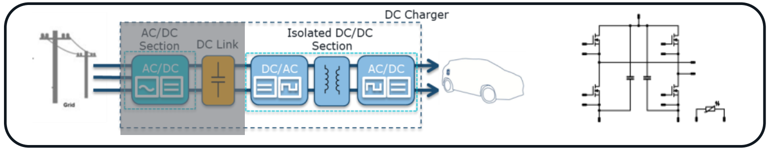
Vincotech

fastPACK SiC and New flowCON SiC Product Line for the DC/DC Stage

Housing	H-Bridge	2ph Ultrafast Rectifier	3ph Ultrafast Rectifier
flow 0	-1200V/75mOhm,32mOhm SiC MOSFET Gen3 and Gen4 -950V/35mOhm,16mOhm SiC MOSFET Gen3 -650V-750V/45mOhm,20mOhm SiC* MOSFET Gen3 and Gen4	-650V/20A SiC SBD	
flow 1	-1200V/11mOhm SiC MOSFET Gen3* -650V-750V/11mOhm SiC* MOSFET Gen3 and Gen4	-1200V/60A,100A,120A Si fast diode and 60A,80A,100A SiC SBD -650V/160A Si fast diode and 60A,80A,100A SiC SBD	- 650V/70A Si fast diode
flow E1	-1200V/32mOhm,16mOhm SiC MOSFET Gen3 -650V/21mOhm,16mOhm SiC MOSFET Gen3	-1200V/10A,30A SiC SBD	
flow E2	-1200V/16mOhm,11mOhm SiC MOSFET Gen3 -750V/20mOhm SiC MOSFET Gen4	-1200V/80A SiC SBD*	- 1200V/40A SiC SBD
flow S3		-1200V/80A SiC SBD	



DC Charger Product Roadmap



*Assuming a typical charging operation point LLC: Vdc 800V, Vout 400V, fsw 100kHz, Ths 80°C

Voltage	Product Line	Technology	Product Family	Part Number	I_{Cnom} [A]							Application Power rating*	2023				2024				2025			
					15	30	40	50	75	80	100		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1200V	fastPACK 0	IGBT4 HS/CAL Diode	P62x, P72x	V23990-P627-F8x-PM V23990-P629-F48-PM V23990-P729-F4x-PM								up to 12 kW												
		IGBT fast H/CAL Diode	P62x	10-FZ124PA040F2-P629F38								up to 12 kW												
		IGBT7 H7 / EC7		10-PC124PA040H7								up to 12 kW												
	fastPACK 1	IGBT4 HS/CAL Diode	L58x	10-xY124PA040SH-L588F48 10-xY124PA080SH-L589F48								up to 22 kW												
		IGBT fast H/CAL Diode		10-FY124PA080F2-L589F38								up to 22 kW												
		IGBT7 H7 / EC7		10-PY124PA080H7								up to 22 kW												
650V	fastPACK 0	IGBT5 H5/Rapid1S	P62x, L62x	10-xZ074PA030SM-L623F08x 10-xZ074PA050SM-L624F08 V23990-P623-F5x-PM 10-xx074PA075SM-L625F0xx								up to 22 kW												
		IGBT fast RGW/RGTV Diode	L62x	10-FZ074PA050RG-L624F88 10-PZ074PA075RG-L625F88Y								up to 22 kW												
	fastPACK 1	IGBT5 H5/Rapid1S	L58x	10-xY074PA100SM-L583Fxx								up to 30 kW												

Ongoing R&D Project

Product Concept

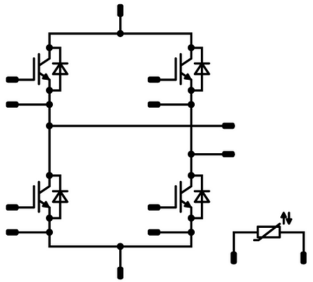
Serial Status

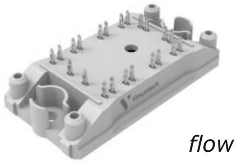
DC Charger Product Roadmap
Product Concept *fast*PACK 0 and *fast*PACK 1

Vincotech

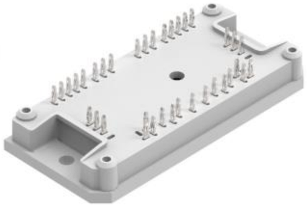
Features

- Latest generation 1200V IGBT7-H7 (TRENCHSTOP™ High Speed Chip) and EMCON 7 Rapid Diode
  - Low saturation voltage, VCEsat
  - Low forward voltage (VF)
  - Soft, fast switching
- Optional with DC link caps and open emitter configuration
- Potential applications: Charging, Welding, UPS, String Inverter





flow 0 P62x



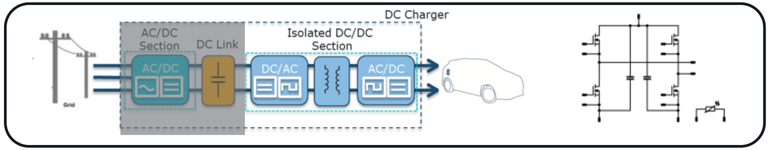
flow 1 L58x

Housing	Main chip technology	Prel. BOM	Part Number
flow 0	1200V IGBT7 H7	1xIGC25T120X12Q (40A) 1xIDC14D120X8Q (40A)	10-PC124PA040H7
flow 1	1200V IGBT7 H7	2xIGC25T120X12Q (80A) 2xIDC14D120X8Q (80A)	10-PY124PA080H7

- Can be offered also as Half-bridge, flowDUAL 0 (1200V/80A) and flowDUAL 1 (1200V/160A)

Housing	Main chip technology	Prel. BOM	Part Number
flow 0	1200V IGBT7 H7	2xIGC25T120X12Q (40A) 2xIDC14D120X8Q (40A)	10-PC122PA080H7
flow 1	1200V IGBT7 H7	4xIGC25T120X12Q (80A) 4xIDC14D120X8Q (80A)	10-PY122PA160H7

DC Charger Product Roadmap



*Assuming a typical charging operation point LLC: Vdc 800V, Vout 400V, fsw 100kHz, Ths 80°C

Voltage	Product Line	Technology SiC Insdie	Product Family	Part Number	R_{DSon} [mOhm]												Application Power rating*	2023				2024				2025			
					5	11	16	17	18	20	28	32	35	45	62	75		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1200V	fastPACK 0 SiC	SiC MOSFET Gen3	L62x	10-PZ124PA075ME03-L627F28Y 10-PZ124PA032ME03-L629F98Y								Serial				Serial	up to 8 kW up to 20 kW	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
		SiC MOSFET Gen4	L62x	10-PZ124PA062MR-L628F18Y 10-PZ124PA036MR-L629F18Y									Serial		Serial		up to 10 kW up to 20 kW	R&D	R&D	R&D	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
	fastPACK E1 SiC	SiC MOSFET Gen3	LQ1x	10-EZ124PA032ME-LQ17F18T 10-EZ124PA016ME-LQ18F18T			Serial					Serial					up to 20 kW up to 30 kW	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
		SiC MOSFET Gen4	LR0x	10-EZ124PA018MR-LR09F08T					Serial								up to 30 kW	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
	fastPACK 1 SiC	SiC MOSFET Gen3	L58x	10-PY124PA011ME		Concept											up to 60 kW	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept				
	fastPACK E2 SiC	SiC MOSFET Gen3	LP4x	10-EY124PA016ME-LP49F18T 10-EY124PA011ME-LP40F18T		Serial	Serial										up to 45 kW up to 60 kW	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
900V	fastPACK 0 SiC	SiC MOSFET Gen3	L62x	10-PC094PB035ME02-L629Fx6Y 10-xx094PB017ME02-L620F3xx				Serial					Serial				up to 25 kW up to 30 kW	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
650V	fastPACK 0 SiC	SiC MOSFET Gen3	L62x	10-PZ074PA045ME 10-PZ074PA023ME 10-PZ074PA015ME			Concept			Concept				Concept			up to 10 kW up to 15 kW up to 20 kW	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept
		SiC MOSFET Gen4	L62x	10-PZ084PA045MR 10-PZ084PA023MR 10-PZ084PA015MR			Concept			Concept				Concept			up to 10 kW up to 15 kW up to 20 kW	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept
	fastPACK 0	Si MOSFET CFD7	L62x	10-PZ064PA073F7 10-PZ064PA045F7 10-PZ064PA028F7							Concept			Concept		Concept	up to 8 kW up to 12 kW up to 15 kW	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept
	fastPACK E1 SiC	SiC MOSFET Gen3	LQ1x	10-E1074PA023ME01-LQ12F68Z 10-E1074PA015ME01-LQ13F68Z			R&D			R&D							up to 15 kW up to 20 kW	Concept	Concept	Concept	Concept	Concept	R&D	R&D	R&D	Serial	Serial	Serial	Serial
	fastPACK 1 SiC	SiC MOSFET Gen3	L58x	10-PY074PA011ME		Concept											up to 30 kW	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept
		SiC MOSFET Gen4	L58x	10-PY084PA011MR		Concept											up to 30 kW	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept
	fastPACK 1	Si MOSFET CFD7	L58x	10-PY064PA018F7 10-PY064PA009F7		Concept			Concept								up to 25 kW up to 35 kW	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept	Concept
	fastPACK E2 SiC	SiC MOSFET Gen4	PB3x	10-EY084PA023MR01-PB32F46T						R&D							up to 15 kW	R&D	R&D	R&D	R&D	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial

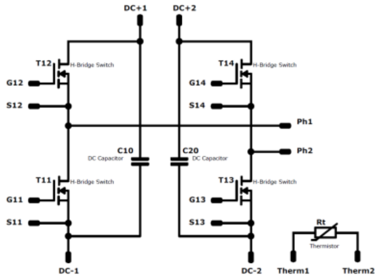
- Ongoing R&D Project
- Product Concept
- Serial Status

DC Charger Product Roadmap
Product Concept *fast*PACK 1 SiC

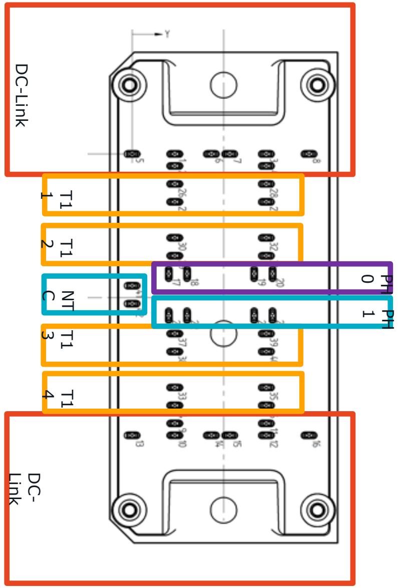
Vincotech

Features

- Latest generation SiC MOSFET
- Optimized layout/pinout
  - Multi coupled DC-link input for each half-bridge
  - Symmetrical power loops for each components
  - Very low stray inductance
- Optional with DC link caps
- Potential applications: Charging, Welding, UPS, String Inverters



H-Bridge Schematic

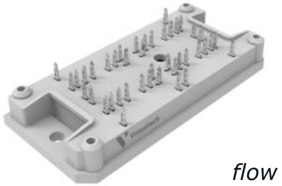


New flow 1 layout/pinout and PCB routing

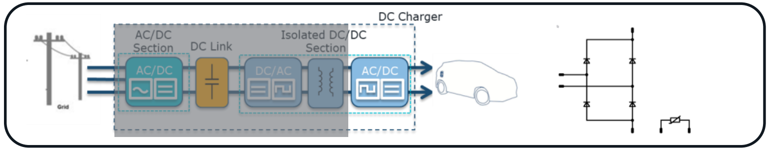
Housing	Main chip technology	Prel. BOM	Part Number
flow 1	1200V SiC MOSFET gen4	4xCPM4-0120-0149JS0A	10-FY124PB007ME
flow 1	1200V SiC MOSFET gen2	4xWF0040N-1200_G2	10-FY124PB010MS

- Can be offered also as Half-bridge

Housing	Main chip technology	Prel. BOM	Part Number
flow 1	1200V SiC MOSFET gen4	8xCPM4-0120-0149JS0A	10-FY122PA004ME
flow 1	1200V SiC MOSFET gen2	8xWF0040N-1200_G2	10-FY124PB005MS


flow 1

DC Charger Product Roadmap



*Assuming a typical charging operation point LLC: Vdc 800V, Vout 400V, fsw 100kHz, Ths 80°C

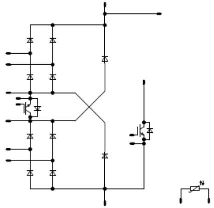
Voltage	Product Line	Technology	Product Family	Part Number	I_{Cnom} [A]											Application Power rating*	2023				2024				2025			
					10	18	20	30	40	60	70	80	100	120	160		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1700V	fastPACK E1 SiC	SiC SBD	LS0x	10-EZ174RA018RO-LS07J83T												up to 13 kW												
1200V	fastPACK 0 SiC	SiC SBD	LH0x	10-PZ12ORA100RO-LH00J88Y												up to 30 kW												
	fastPACK 1	Fast Diode	LH0x	10-PY120RA060VH-LJ92I08Y 10-PY120RA060VH01-LJ92I03Y 10-PY12ORA100CA-LJ95I03Y 10-PY12ORA120VH-LJ96I03Y												up to 35 kW												
	fastPACK 1 SiC	SiC SBD	LJ5x	10-PG12ORA060CD-LJ58I18T 10-PG12ORA080CD-LJ59I18T												up to 50 kW												
				10-PG12ORA100RO-LJ50I48T 10-PG12ORA100CD-LJ50I18T												up to 60 kW												
	fastPACK E1 SiC	SiC SBD	LS0x	10-EZ124RA010RO-LS06J88T 10-EZ124RA030RO-LS08J88T												up to 25 kW												
	fastPACK E2 SiC	SiC SBD	LP4x	10-EY124RA080CD												up to 50 kW												
	flowCON E2 SiC	SiC SBD	PJ1x	10-EY126RA040CD-PJ17J98T												up to 25 kW												
	fastPACK S3 SiC	SiC SBD	LM9x	B0-SP12ORA080RO-LM90J48T												up to 50 kW												
650V	fastPACK 0 SiC	SiC SBD	LH0x	10-PZ07O2A020RO-LH01J88Y												up to 15 kW												
	fastPACK 1 SiC	SiC SBD	LJ5x	10-PG07ORA060RO 10-PG07ORA080RO 10-PG07ORA100RO-LJ51I48T												up to 60 kW												
	fastPACK 1	Fast Diode	LJ5x	10-PG07ORA160RF-LJ53I88T												up to 50 kW												
	flowCON 1	Fast Diode	L82x	10-FY076RA070VH-L824J58												up to 25 kW												

Ongoing R&D Project

Product Concept

Serial Status

*fast*PACK S3 SiC



- Latest generation SiC SBD for high switching and high efficiency
- Ready for 400 V and 800 V battery systems
- Optional w/ or w/o discharge switch

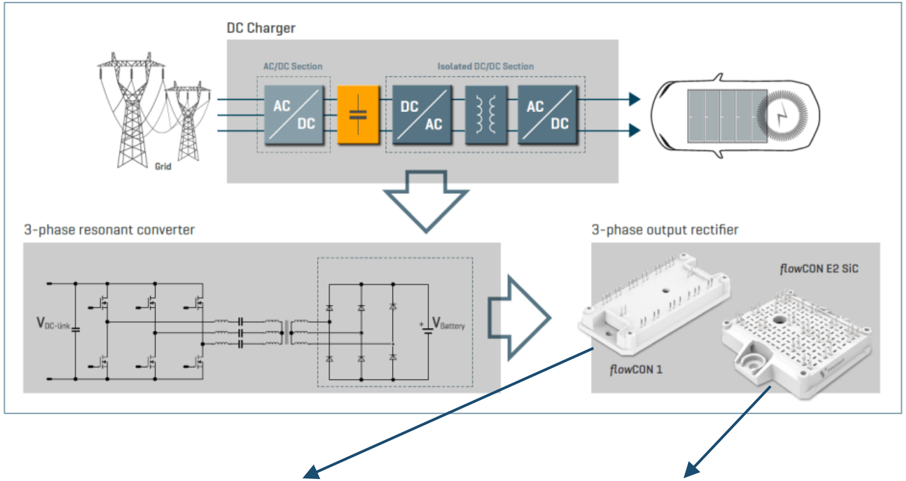
DC Charger Product Roadmap

New
***flow*CON 1 and *flow*CON E2 SiC**

/ Ultra-efficient **3-phase output rectifier** power module

/ Enables **compact, light, and cost-effective** designs with **better loss distribution** and **less stress** on passive and active devices

/ Multi-sourced, latest-generation 650 V and 1200 V Si fast-recovery and SiC diodes



Basic module information

Part number:	10-FY076RA070VH-L824J58
Product line:	*flow*CON 1
Product status:	Samples available
Break down voltage:	650 V
Nominal chip current rating:	70 A
Standard Packing Quantity:	100

Basic module information

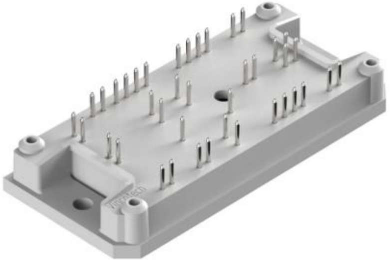
Part number:	10-EY126RA040CD-PJ17J98T
Product line:	*flow*CON E2 SiC
Product status:	Samples available
Break down voltage:	1200 V
Nominal chip current rating:	40 A
Standard Packing Quantity:	100

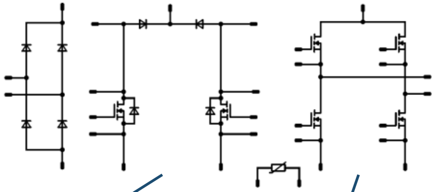
VIN DC Charger Product Solutions

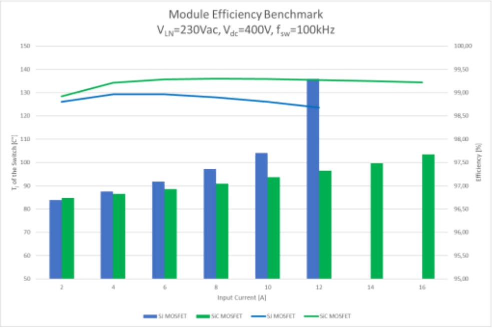
DC Charger Product Roadmap for compact designs

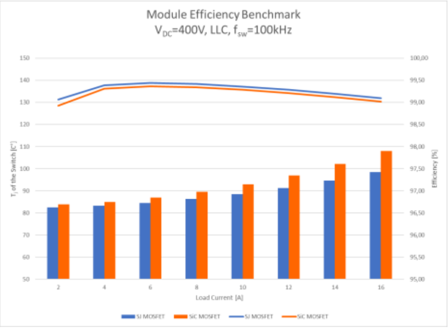
DC Charger Product Roadmap for compact designs

flowRPI 1









Single-phase rectifier+PFC boost+H-Bridge for isolated DC-DC power conversion: 3-in-1 module for highly **compact PCB designs**

- Rectifier: high efficiency low voltage drop diodes
- PFC:2 legs 650V IGBT H5 + ultrafast diodes or latest 600V P7 CoolMOS chip technology and SiC SBD for high-frequency and high-efficiency switching
- H-Bridge: 650V IGBT H5 or latest CFD7 CoolMOS chip technology for high-frequency and high-efficiency switching

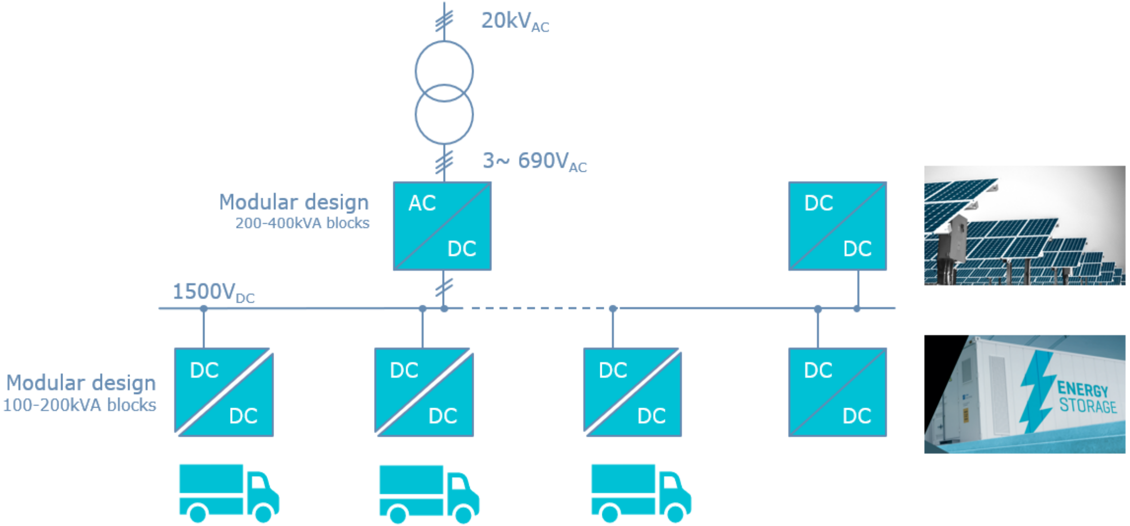
Outlook
- 650V SiC MOSFET Tech is outperforming SJ MOSFET in terms of performance and costs

VIN DC Charger Product Solutions

DC Charger Product Roadmap for MCS

DC Charger Product Roadmap for MCS

Preliminary system architecture for MW Charger



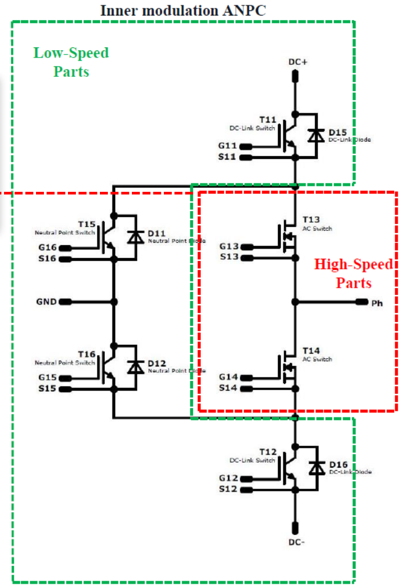
DC Charger Product Roadmap for MCS

AC/DC unit – *flow*ANPC 1 with SiC MOSFETs

Features

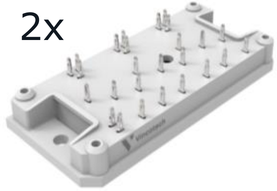
- Optimized for 1500 Vdc application up to 200 kW
- ANPC with inner switch modulation
- SiC MOSFETs for inner switch
- Easy split into low- & high-speed modules
  (optimal power loss distribution between LS and HS parts at ~40 kHz)
- Cost/performance optimized Si/SiC hybrid chipset
- Low inductive flow 1 packages with Al_2O_3 DCB
- Pin positions optimized for easy module arrangement and PCB layout
- For advanced heat sink with heat pipes

standalone half-bridge module, which can be used as H-bridge for DC/DC stage



Power Class	Housing	Current rating	Main chip technology	Part number
200 kW	*flow* 1	~5-6 mΩ	1200 V SiC MOS	tbd.
	flow 1	140 A	1200 V Si IGBT M7	tbd.
Concepts				

2x

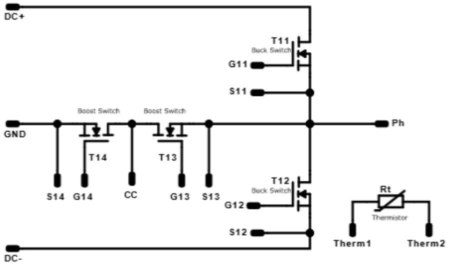


DC Charger Product Roadmap for MCS

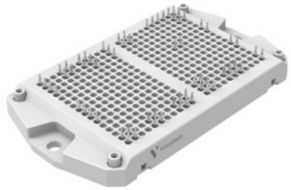
AC/DC unit – *flow*MNPC E3 with SiC MOSFETs

/ **Features**

- Optimized for 1500 Vdc application up to 250 kW
- Three-level MNPC topology
- Full SiC technology using 2kx SiC MOSFETs in buck switch
- Low inductive *flow* E3 with Al_2O_3 DCB
- Pin positions optimized for easy module arrangement and PCB layout



Power Class	Housing	Current rating	Main chip technology	Part number
250 kW	*flow* E3	~4 mΩ	1200 V SiC MOS	tbd.
Concepts				



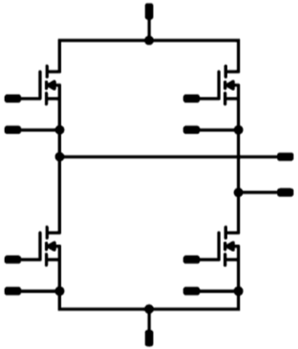
DC Charger Product Roadmap for MCS

DC/DC unit – *fast*PACK S3 with SiC MOSFETs

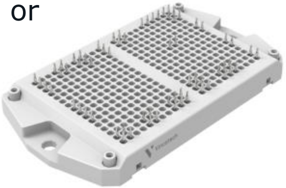
Features

- Optimized for 1500 Vdc application using 2x00V SiC MOSFETs (optionally 1.7 kV SiC MOSFETs)
- *Operation in resonant mode at fixed output voltage and the use of a secondary DC/DC stage lead to higher system efficiency at lower battery voltages
- Low inductive *flow* S3, or *flow E3* packages with Al_2O_3 DCB
- Pin positions optimized for easy module arrangement and PCB layout

2x



or



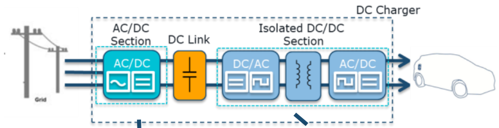
Power Class	Housing	Current rating	Main chip technology	Part number
~75 kW	*flow* S3/E3	~10 mΩ	1700 V SiC MOS	tbd.
~75 kW	*flow* S3/E3	~8 mΩ	2x00 V SiC MOS	tbd.
Concepts				

VIN DC Charger Product Solutions

DC Charger VIN reference designs

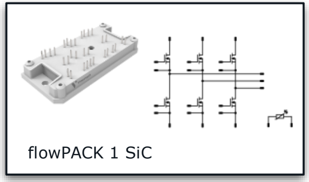
DC Charger VIN reference designs

22kW full-SiC bi-directional DC Charger Design Proposal



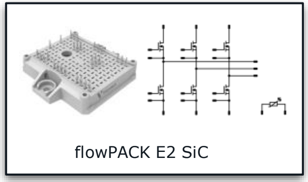
SiC Inside

2L topology
- 1 Module solution



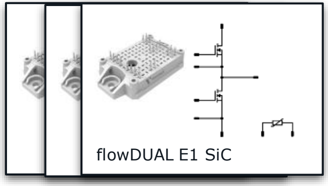
1x 10-FY126PA021ME-L227F68

or



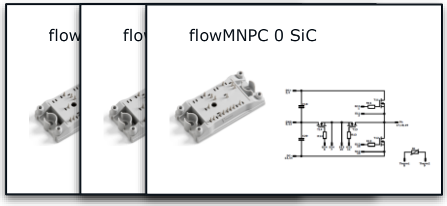
1x 10-EY126PB021ME-PJ17F18T

2L topology
- 3x Module solution



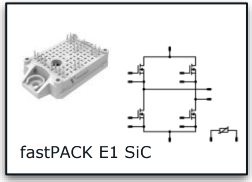
3x10-EZ122PA021ME-LJ6xxx in concept

3L topology
- 3 x Module solution

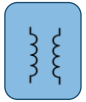


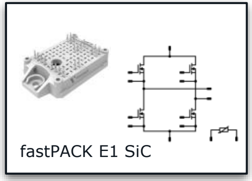
10-FZ12NMA032ME-M26xxx in concept

SiC Inside

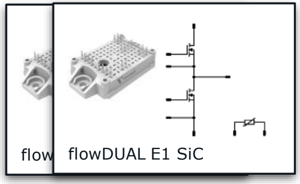


1x 10-EZ124PA032ME-LQ17F18T

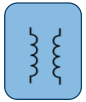


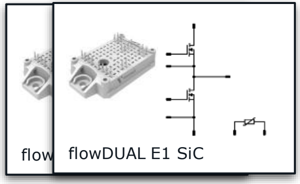


1x 10-EZ124PA032ME-LQ17F18T



2x 10-EZ122PB032ME-PE07F18T

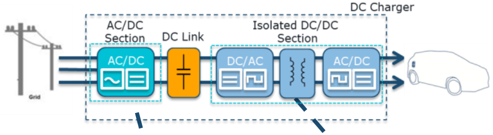


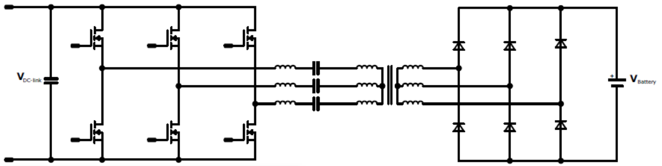


2x 10-EZ122PB032ME-PE07F18T

DC Charger VIN reference designs
22kW full-SiC DC Charger Design Proposal

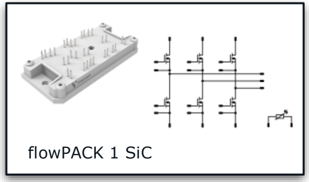
Vincotech





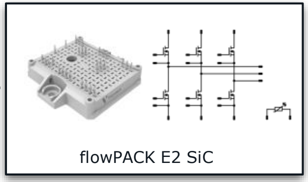
SiC Inside

2L topology
- 1 Module solution



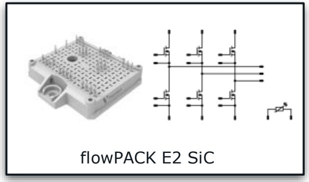
1x 10-FY126PA021ME-L227F68

or

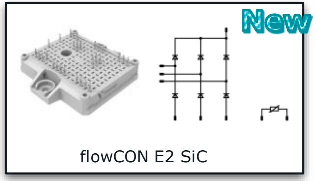


1x 10-EY126PB021ME-PJ17F18T

1200V

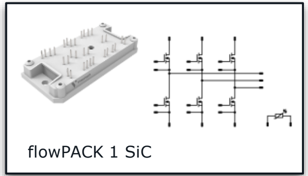


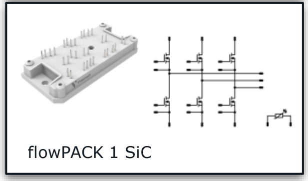
1x 10-EY126PB021ME-PJ17F18T



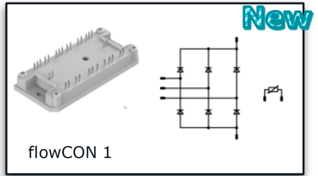
1x 10-EY126RA040CD-PJ17J98T

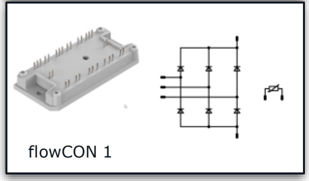
650V in series or parallel





2x 10-FY086PA023MR-L222F48





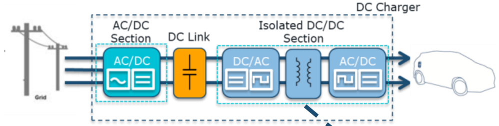
2x 10-FY076RA070VH-L824J58

- The three-phase LLC resonant converter achieves high efficiency at full load by distributing losses across three phases and also reduces stress on the capacitor and power switches

DC Charger VIN reference designs

30kW DC Charger Design Proposal with New PFC Concept Proposal for DC Charger

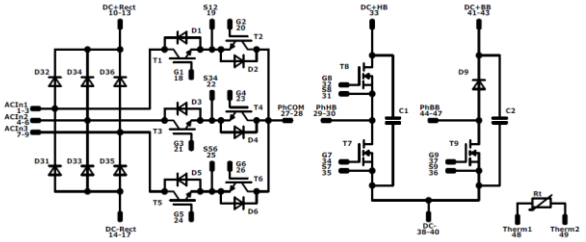
- **New Current Synthesizing PFC (CSPFC) topology** for highest efficiency at lowest total system costs through
  - Reduced number of SiC devices
  - Reduced number and size of the PFC inductors
- **Latest SiC-MOSFET chip technology** for high speed switching and high efficiency up to 100 kHz and >99% respectively
- Bi-directional ready
- Thin Al_2O_3 substrate eases the system's thermal design
- Temperature sensor



Any existing H-Bridge product

flowCSPFC S3

B0-SP12CFA016ME-PD98G68T

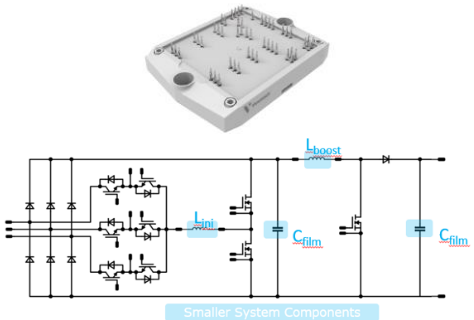


Voltage	Product Line	Technology SiC Inside	Product Family	Part Number	RDSon [mOhm]			Application Power rating*	2023				2024				2025			
					11	16	22,5		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1200V	flowCSPFC S3	SiC MOSFET/SiC Diode	PD9x	B0-SP12CFA016ME-PD98G68T				Up to 35 kW												

DC Charger VIN reference designs

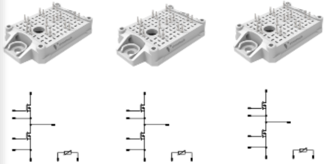
30kW DC Charger Design Proposal with New PFC Concept Proposal for DC Charger

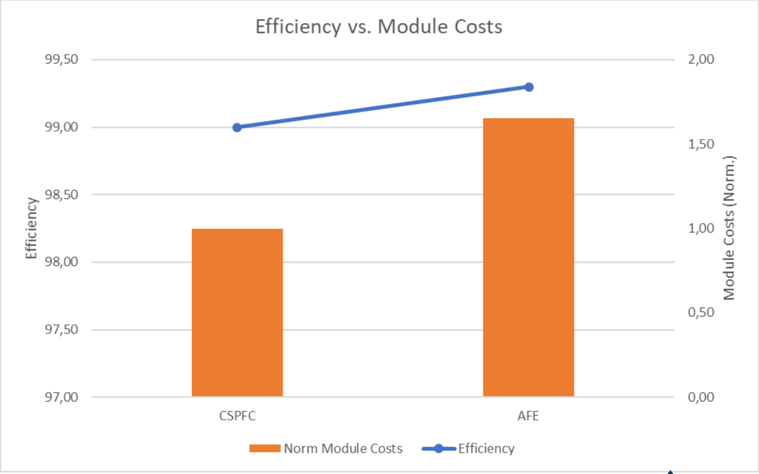
1xflowCSPFC S3 SiC



VS

3xflowDUAL E1 SiC

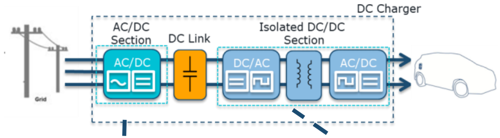




Lowest total system costs through

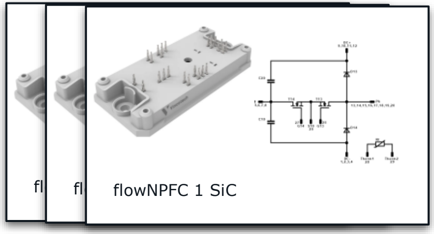
- less SiC devices ➔ reduced power module costs
- higher switching frequency ➔reduced passive components costs

DC Charger VIN reference designs
60kW Uni-directional DC Charger Design Proposals

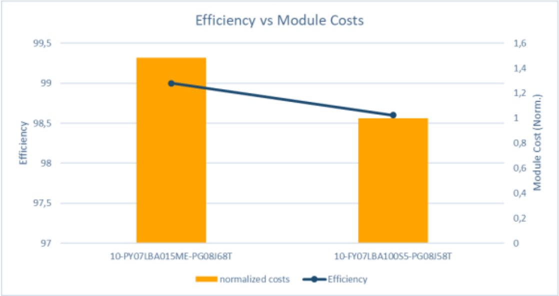


SiC Inside

3L topology
- 3 x Module solution

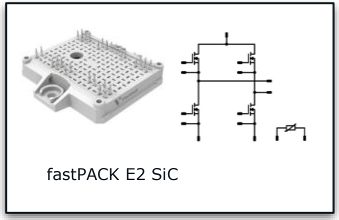


3x10-PY07LBA015ME-PG08J68T (SiC MOSFET) or
3x10-FY07LBA100S5-PG08J58T (IGBTS5)

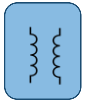


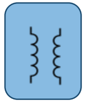
Application: Vin 230V, Vout 800V, fsw 40kHz

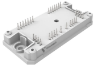
SiC Inside

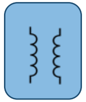


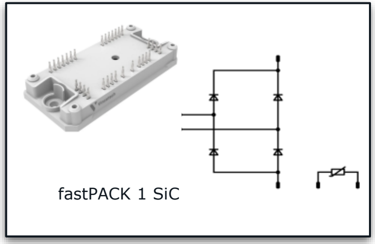
1x10-EY124PA011ME-LP40F18T or
1x10-PY124PA011ME L58xxx in concept (flow 1)



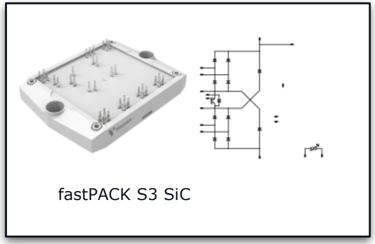






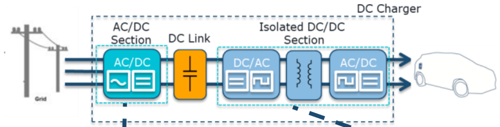


1x10-PG12ORA080CD-LJ59I18T or
1x10-PG12ORA100CD-LJ50I18T



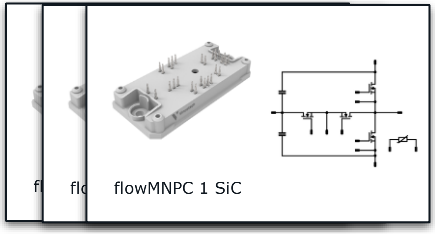
B0-SP12ORA080RO-LM90J48T

DC Charger VIN reference designs
60kW bi-directional DC Charger Design Proposals



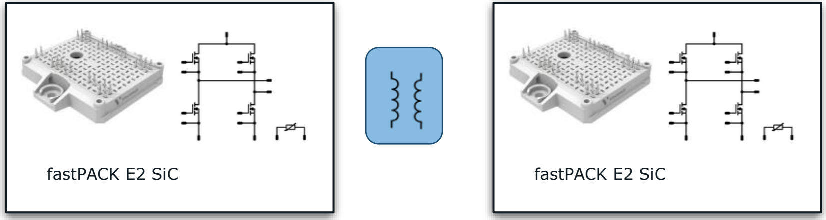
SiC Inside

3L topology
- 3 x Module solution

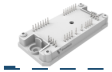


3x10-PY12NMD016ME-PG08F18T or
3x10-EY12NMA016ME-LS28F16T (flow E2) or
3x10-EY12NMA011ME30-LS28F18T (fllow E2) or
3x10-EY12NMA013MS-LS2xFxxT in concept (flow E2)

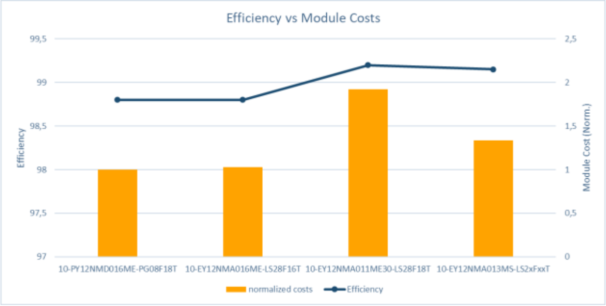
SiC Inside



1x10-EY124PA011ME-LP40F18T or
1x10-PY124PA011ME_L58xxx in concept (flow 1)



1x10-EY124PA011ME-LP40F18T



- 10-PY12NMD016ME-PG08F18T with 650V and 1200V SiC MOSFETs (Gen3)
- 10-EY12NMA016ME-LS28F16T with 650V and 1200V SiC MOSFETs (Gen3)

- 10-EY12NMA011ME30-LS28F18T full 1200V SiC MOSFETs (Gen3)
- 10-EY12NMA013MS-LS2xFxxT full 1200V SiC MOSFETs (Gen2)

Application: Vin 230V, Vout 800V, fsw 40kHz

EMPOWERING **YOUR IDEAS**