

Company Presentation

Foxy Power GmbH

16.01.2024 | General Introduction



## Mission Statement

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*„To drive disruptive technologies and innovative products into the power electronic market and enable the best cost performance system possible.“*

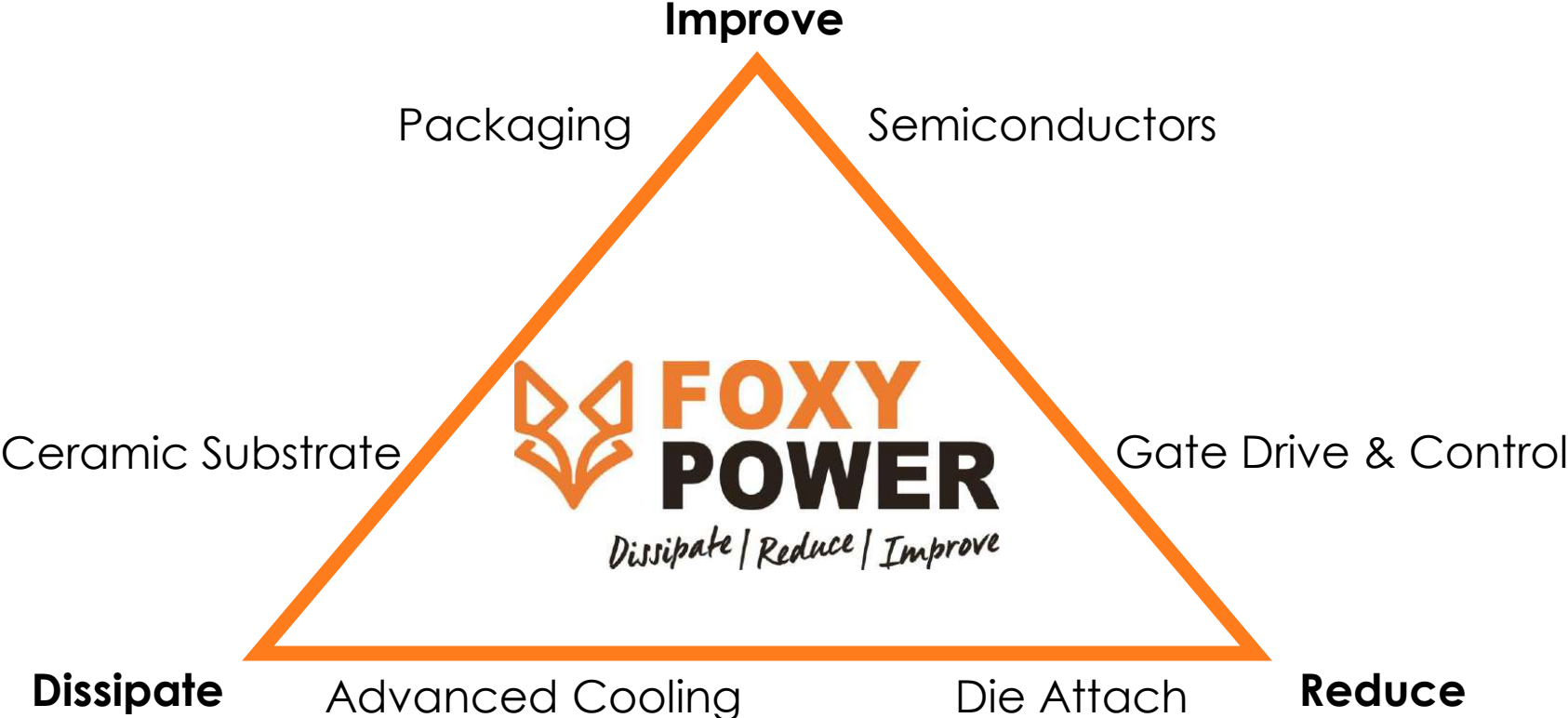
## WHAT WE DO

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Business Development: Disruptive technologies and innovative products

Consulting: Strategy. Products. Markets.

# Best cost/performance system as the goal in power electronics



# FOXY POWER In A Nutshell



Thin & ultra-low weight coolers  
 Heat flux density of 240W/cm<sup>2</sup> per side  
 Cooling for semiconductors & passives



Estb. global Vendor in Automotive and industrial  
 Wide semi product portfolio (Si | SiC | others)  
 Vertical integration of SiC supply chain



Si and Polyurethane resin which significantly improves heat transfer  
 Non-hazardous, electrically isolated and fire resistant  
 No requalification necessary



Si IGTO combines IGBT and Thyristor features  
 Improved efficiency vs. IGBTs and automotive qualified available 1200V devices (Roadmap)  
 Loss parameters can be modified to customers requirements



Power Stack

Stackable, scalable, modular, lightweight and miniaturized power stack platform  
 Technology and die agnostic (Si, SiC, GaN ...)  
 Signed contract for mass production at Tier 1 location



GaN on Sapphire as cost-effective, high-performance material  
 GaN Diodes, HEMTs & Gate Drivers  
 Novawave looking into 300V GaN Schottky Diodes

# FOXY POWER In A Nutshell



Vincotech



High quality modules design in Germany

Flexible and innovative (Si, SiC, GaN, GaAs)

Many topologies' options in various housings



ANALOG POWER



Low voltage p- & n-channel Si MOSFETs

Custom packaging possible

High voltage MOSFETs and new technologies



Equipment for semiconductor and photovoltaic industries



Soldering & Sintering equipment

Consulting in Ag- and Cu-Sintering

Module development and prototypes



Enables longer EV range, lower system cost

AI based soft switching solution for DC/AC inverter; Enables power density of >200kW/liter

Reduces 99% (SiC) switching losses and reaches 5% load efficiency >99%



Nano-Join



Next generation Ag & Cu sintering paste

12x lower thermal resistance

10x improved lifetime



Consulting services for advanced motor design

Fast PCBA manufacturing service (5-10 days)

Logistics Services as required via 3<sup>rd</sup> party

# IQ evolution 3D Printed Liquid Cooled Heatsinks

Founded in 2006 in Aachen, Germany

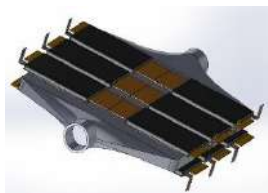
Started with manufacturing of coolers for high power laser diodes

Financially self-sustainable and well backed for investments

IQ-Big 53 Auto V.10 can cool 12 E3 packages

Cooling performance **reduces** number of **chips**

**Corrosion free** cooling of semiconductors & passives



IQ-Big 53 Auto V.10

Stainless steel enables very thin wall thicknesses and cooling through turbulences; Easy to sinter and solder on stainless steel

Al coolers for automotive requirements under development

Flexible form and shapes

IQ „Thin“ can be **embedded** into **PCB**

Thickness only 0.8mm

Connection via O-ring possible

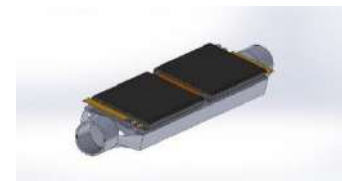


IQ „Thin Cooler“

IQ „E3 four“ with two E3 packages

Flexible in design and **easy scalable**

Paralleling and / or serial cooling possible



IQ „E3 Four“

**Thin & ultra-low weight** coolers

**Heat flux density** of **240W/cm<sup>2</sup>** per side

**Ready** for **automotive quantities**

(1 Twin every 90 sec)



IQ „Twin“





Pre-Switch

# AI based soft switching solution for DC/AC



Embedded AI

World's first AI based soft switching solution for all DC/AC inverters for all varying conditions

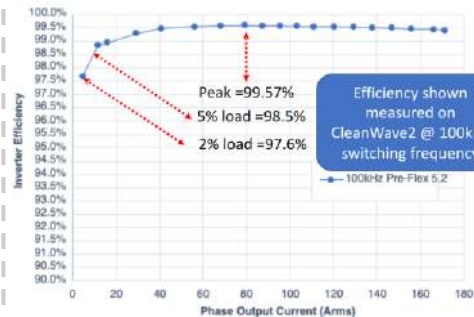


Pre-Flex Chip

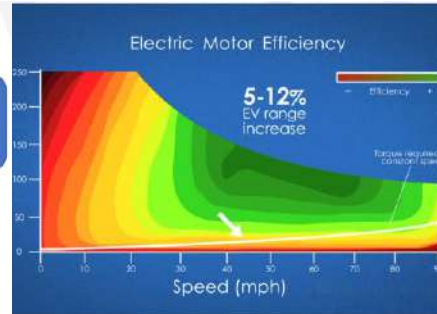
**Reduction of 99% SiC switching losses** (switch agnostic)

Cooler, lighter motor with more torque

Efficiency vs current



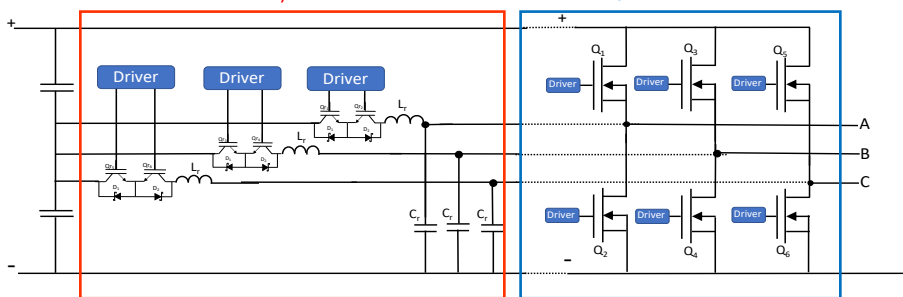
Pre-Switched, SiC, fsw=100kHz



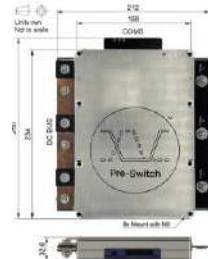
**Pre-Switch improves lower load conditions efficiency at higher efficiency and thus reduces motor losses and battery cost.**

Auxiliary Devices

B6 w/ main switches



**The system cost and performance benefits of soft switching exceed the additional cost and losses of the auxiliary devices by far.**



Cleanwave200 evaluation system

200kVA SiC based bidirectional evaluation block with low load efficiency >99%; peak efficiency >99.6%

**Reduces inverter system cost**, size and weight and enables power density of >200kW/l

**5-12% more EV range** by increasing fsw and reducing motor efficiency





# High reliable & customized power modules

Group company of Mitsubishi Electric Corporation headquartered in Unterhachingen, Germany

Top 5 global power module supplier w/ revenue >>€ 200M

Focused 100% on industrial applications

Reliable Partnership: Long term commitments to customers

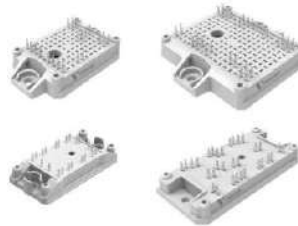
Speed & Flexibility: Samples typically available in 6-8 weeks

Independent of component suppliers and maximum freedom of choice in design

Focused 100% on industrial applications

Top 5 global power module supplier

VINcoSim: Integrated simulation and selection environment for power modules



2-level and special multilevel topologies

Various options with Si, SiC and other semiconductors (GaN, GaAs)

Options for pin type (Press-Fit) and w/ added TIM and Phase Change material

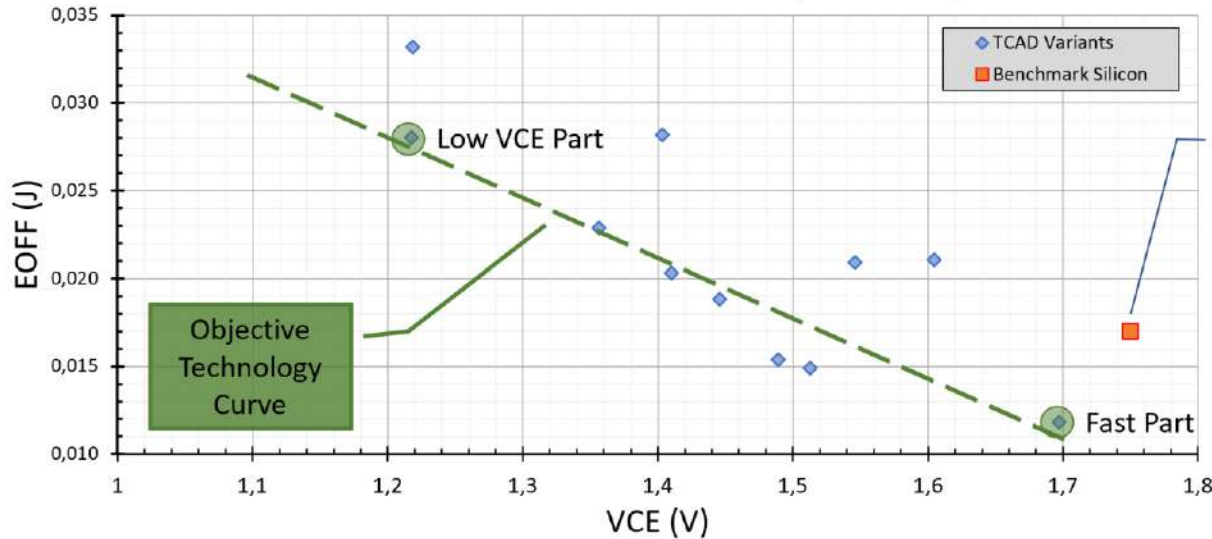






# Closing the gap between Si and SiC

Process variants on  $E_{OFF}$  vs.  $V_{CE}$  plane (w/ 20% smaller die)



TCAD simulation:  $E_{OFF}$  vs.  $V_{CE}$  @150A ( $T_J=175^\circ\text{C}$ )

**Pakal Tech: Developing the next generation Si transistor w/ better physics**

General:

- Silicon Valley, USA based startup
- In the market w/ 650V devices (>5mio pcs)
- Pakal Si IGTO = Best of IGBT & Thyristor
- High current device
- Si = **proven reliability & cost effective**
- IGTO outperforms IGBT in dynamic & static losses
- Pakal **develops 1200V automotive qualified devices**
- Vast demand from automotive industry for cost driven auxiliary inverters will force more than just SiC semiconductors to be available for the market
- Future of powertrain will be mix of Si, SiC & other semiconductor materials



# Innovative GaAs Semiconductors

Founded 2015 in Dresden, Germany using **AZURSPACE** as fab partner;  
1200V GaAs PiN and 300V GaAs Schottky Diodes made in Germany

GaAs second most used semiconductor material in the world w/ multiple established suppliers of GaAs Epitaxy and Wafer

GaAs provides best cost / performance due to easier manufacturing processes and highest current density

GaAs w/ improved cost / performance benefits vs. Si and SiC

GaAs Diodes can be optimized according to their usage in hard- or softswitched topologies ( $V_F / Q_{RR,QC}$ )

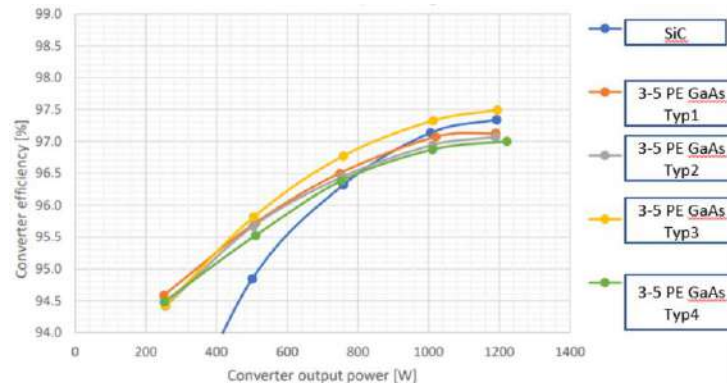
GaAs has lowest  $C_j$ , high surge current and highest current capability enabling smallest die size per rate current

**GaAs provides longterm better pricing** compared to SiC



Relative cost of SiC and GaAs 1200V, 10A, Bare die, diced on blue tape at 100Kpcs per Anno

**1200V GaAs diodes outperforms** 1200V SiC diode



1kW Boost Converter performance comparison (fsw=100kHz, hard switched)





# Industrial Battery Charger

## Low-cost, Lower Power solution



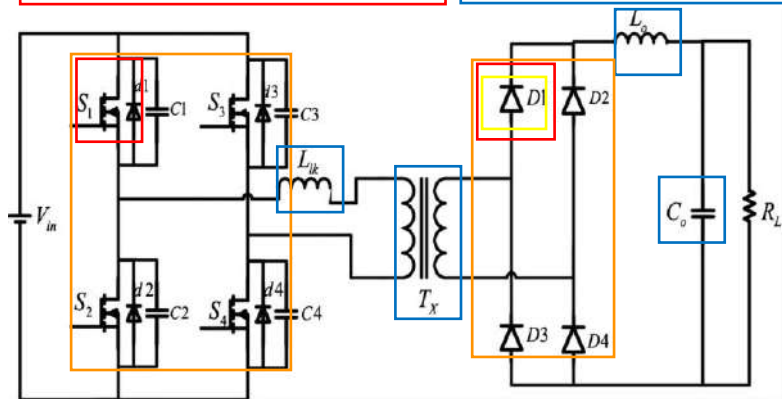
Si Diodes (FRD, Rectifier, Schottky) and Transistors (IGBT, SJ-MOSFET)



300V GaAs Schottky Diodes



Passive components



Si Modules w/ different topologies, packages and options for manufacturing (Press-Fit, Pre-pasted TIM, Phase Change Material)

Vincotech Higher performance at low cost by using Hybrid module (SiC Diode)

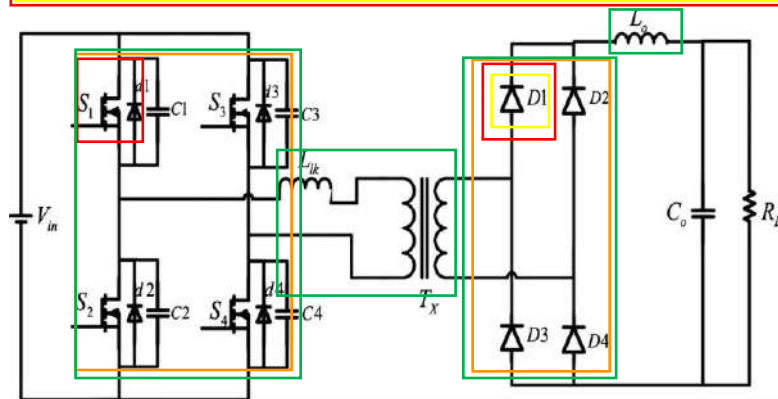
## High Performance, higher power solution



SiC Diodes w/ 650V 1A-50A und 1200V 2A-50A  
SiC MOSFETs w/ 1200V, 40mOhm, 80mOhm, 160mOhm



GaAs PiN Diodes w/ 1200V, 10A, 20A, 30A, 60A in TO-247 3L



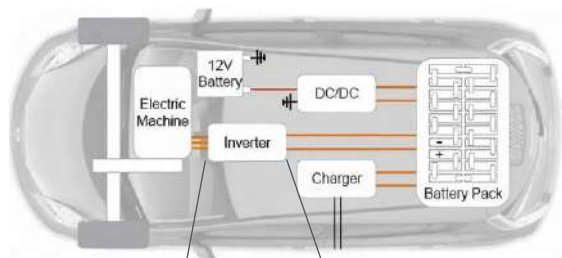
SiC MOSFET and Diode Modules w/ different topologies, packages and options for manufacturing. Future could include GaN Transistors and GaAs diodes as well as integration of heatsinks from IQ



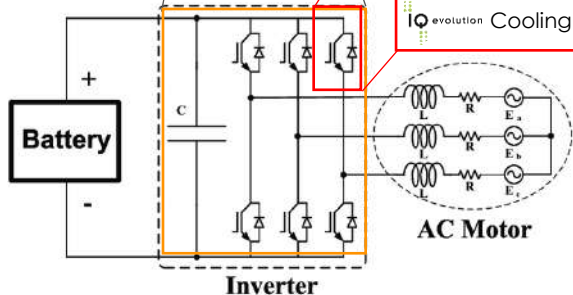
Liquid cooling in the industry from ~300kW



# Automotive powertrain

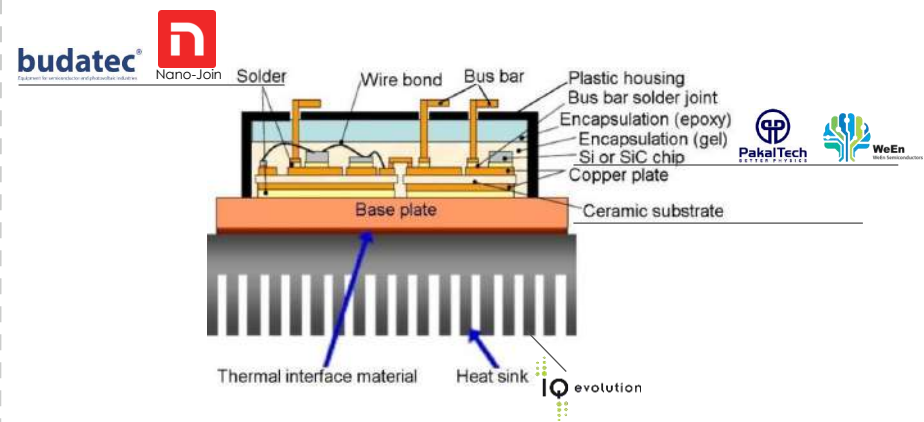


- 650V / 1200V Si IGBT replacement
- 650V / 1200V Si IGBT & SiC MOSFET
- Cooling for semiconductor and passives

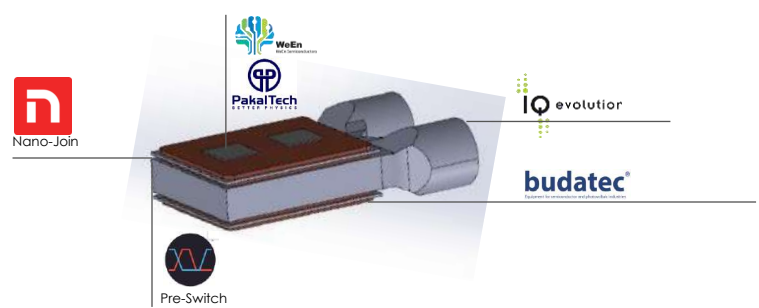


- Stackable, scalable, modular, lightweight and miniaturized power stack platform. Die agnostic. Includes cooling.
- Softswitching for DC/AC inverter. Reduces switching losses and increased switching frequencies. Enable longer EV range

## Today



## Future





**Christopher Rocneau**

Chief Executive Officer

[Chris.rocneau@foxypower.com](mailto:Chris.rocneau@foxypower.com)

Christopher had various roles in the power electronics industry providing business development & technical sales through distributors & working directly for semiconductor manufacturers like CREE Inc, ROHM Semiconductor & others where he was responsible for building territories & finding & designing power devices into key customers. He brings in technical expertise & a worldwide distributor & customer network. He holds an Dipl. Wirt. Ing. (M.Sc.) in Electrical Engineering and Business.



**Michael Doktor**

Chief Commercial Officer

[Michael.Doktor@foxypower.com](mailto:Michael.Doktor@foxypower.com)

Michael had various roles in large industrial companies (50bn€+ revenue) as well as founder of a consulting & business development company. From leading highly technical projects, selling & negotiating deals with >50mn€ volume & advising top management boards on strategy & restructuring across various industries. Additionally, he holds an MBA with focus on strategic management.

# FOXYPower Our partners



Pre-Switch



Tronic One

