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Würth Seminar 22.5.2025

Applikationstopologien in der Elektrifizierung

Michael Lütt

EMEA Automotive Marketing & Application

Agenda

1. ST company introduction
2. Electric powertrain sub-systems in an EV
3. SiC value proposition
4. ACEPACK power modules for EV applications
5. Questions & Answers

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We are creators and makers of technology

One of the world's largest semiconductor companies

50,000 employees
of which **9,000+** in R&D

$13.3 billion revenues
in 2024

Over **80** sales & marketing offices serving over **200,000** customers across the globe

14 main manufacturing sites

Signatory of the United Nations Global Compact (UNGC)
Member of the Responsible Business Alliance (RBA)

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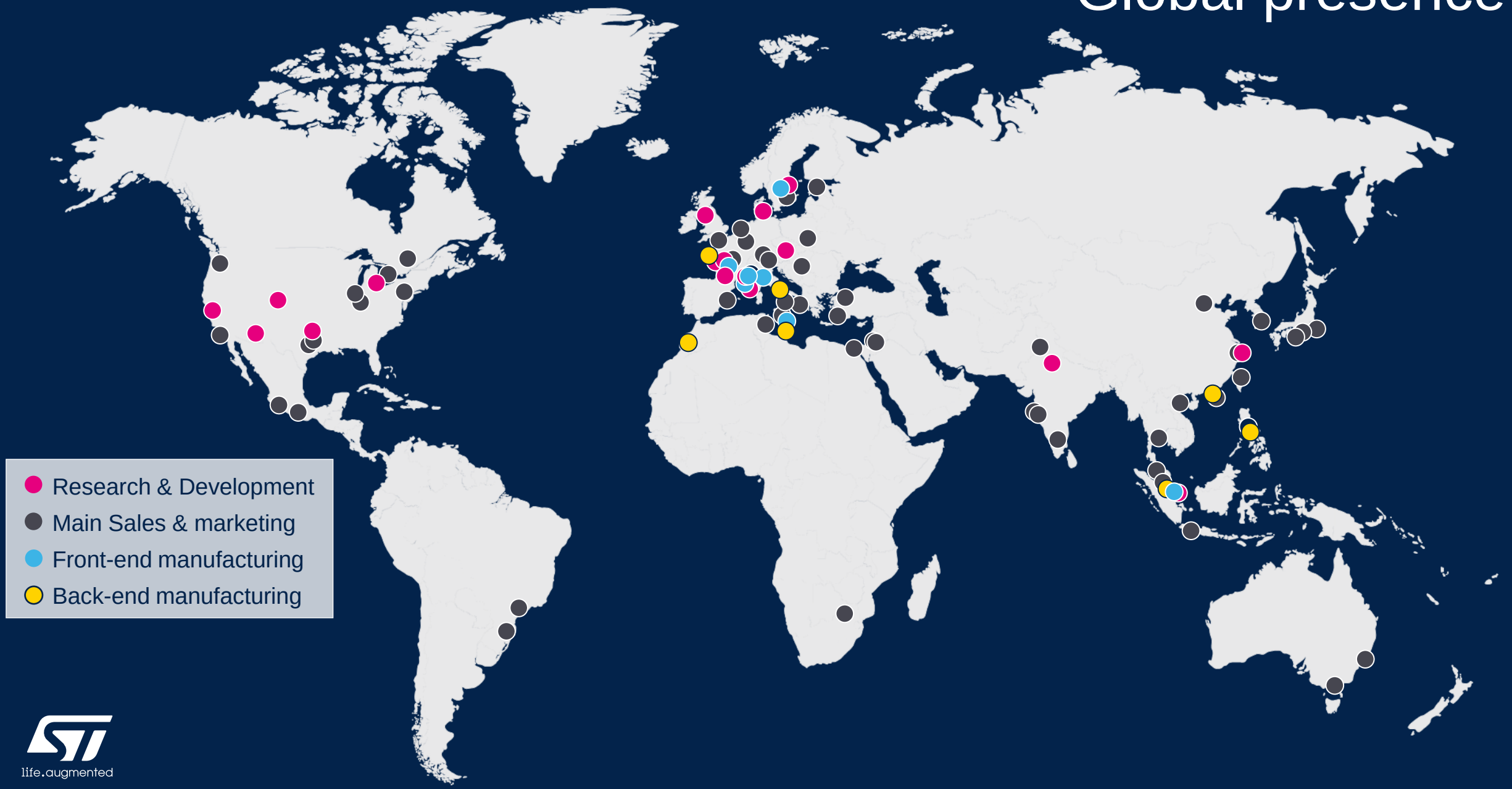
As of December 31, 2024

Global presence



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Our vision

ST stands for

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Everywhere microelectronics
makes a positive contribution to people's lives,
ST is there.

Our strategy stems from key long-term enablers

Smart Mobility

Helping car manufacturers make driving safer, greener, and more connected for everyone

Power & Energy

Enabling industries to increase energy efficiency everywhere and the use of renewable energy

Cloud-connected Autonomous Things

Supporting the proliferation of secure, connected, autonomous devices enabled by edge AI

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ST in Automotive
leading position on all the application domains

Dedicated and Comprehensive Semiconductor Product Portfolio

Supporting our Customers

Enabling Strategic Trends

- Over 30 years of Automotive Experience
- > 30% of ST sales for Automotive market in 2020
- Committed player in the automotive Digitalization, Electrification and traditional applications through semiconductor innovation
- ST at the forefront of mobility evolution

Body & Convenience

Chassis and Safety

In-vehicle Infotainment

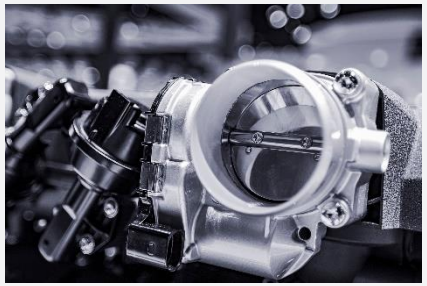
Telematics and Networking

Powertrain for ICE

Electro-mobility

ADAS

Mobility Service



Automotive Motor Control

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Automotive Transformation

Innovation in traditional car electronics

Electrified vehicle

Digital and connected car

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Electric powertrain sub-systems

Electric powertrain sub-systems
Overview

Enabling greater range through higher efficiency and lighter systems

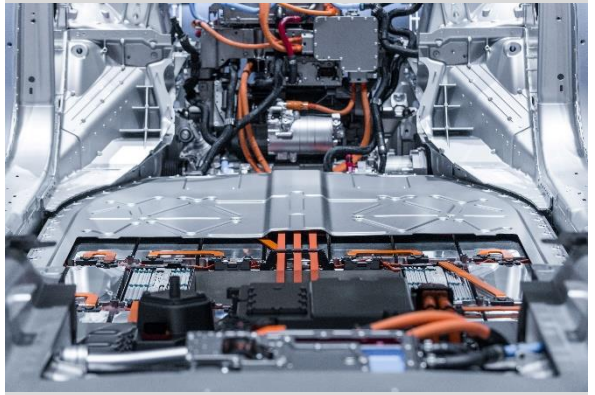
Traction inverters

Greater range and reliability

Onboard chargers

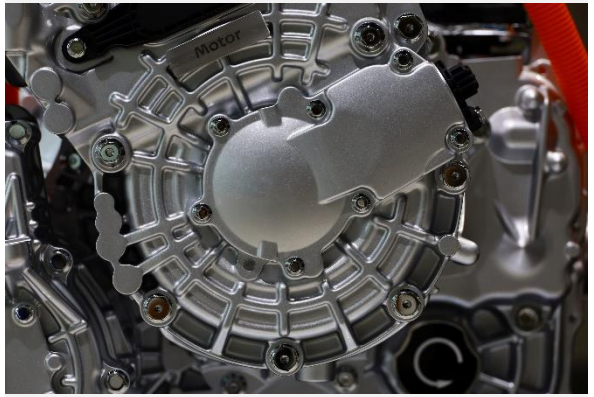
Faster charging

DC-DC converters



Higher efficiency

PTC heater, e-compressor, and other



Smaller and lighter systems

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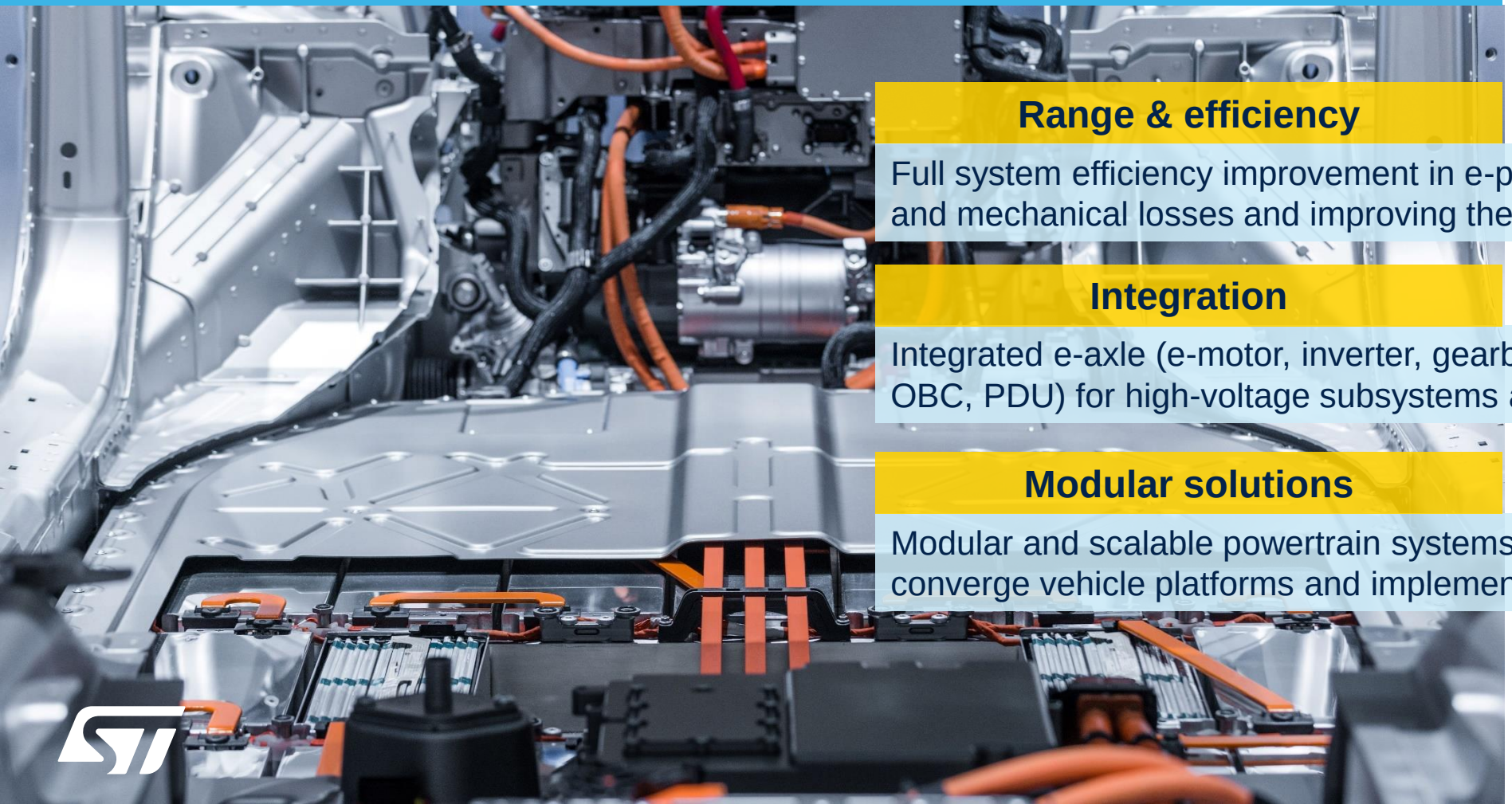
Electric powertrain efficiency, integration, modularity

Enhancing e-powertrain efficiency with integrated, modular, and scalable systems



Range & efficiency

Full system efficiency improvement in e-powertrain by reducing electric and mechanical losses and improving thermal management

Integration

Integrated e-axle (e-motor, inverter, gearbox) and power units (DC-DC, OBC, PDU) for high-voltage subsystems and battery packs

Modular solutions

Modular and scalable powertrain systems (battery, e-motor, inverter) to converge vehicle platforms and implement enabling technologies

OBC = onboard charger
PDU = power distribution unit

Power semiconductor requirements for car electrification

	Traction inverter	100-250 kW	SiC MOSFET	Si IGBT		24-48 transistors
	OBC/DC-DC	11-44 kW	SiC MOSFET	Si HV MOSFET	GaN HEMTs	6-14 transistors
	Charging station DC-DC	100-250 kW	SiC MOSFET			12-18 transistors
	Energy storage	>1 MW	SiC MOSFET			>100 transistors

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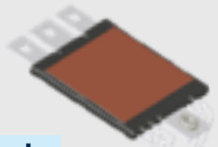
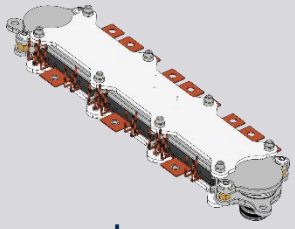
Power package trend from power module to full inverter

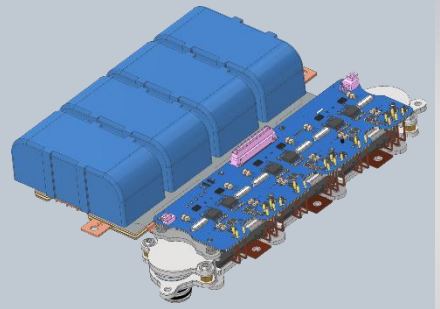


Power module



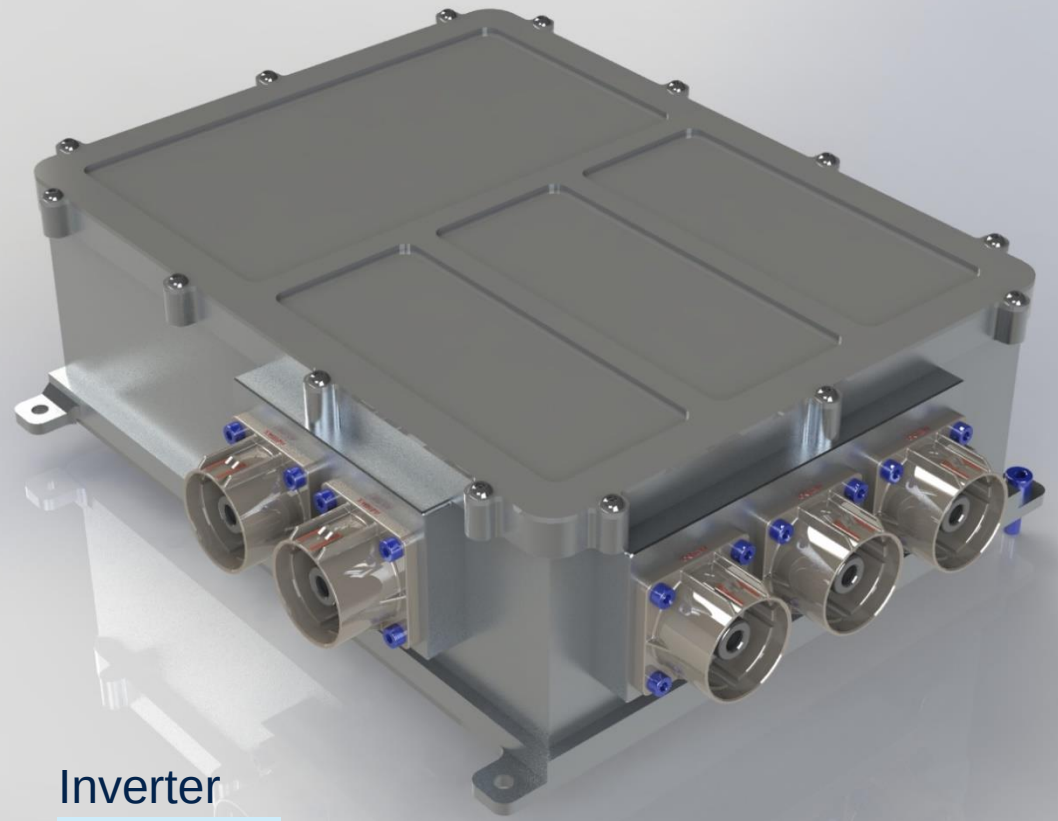
Power box

Power modules + cooler



Power pack

Power box + driver board + DC link

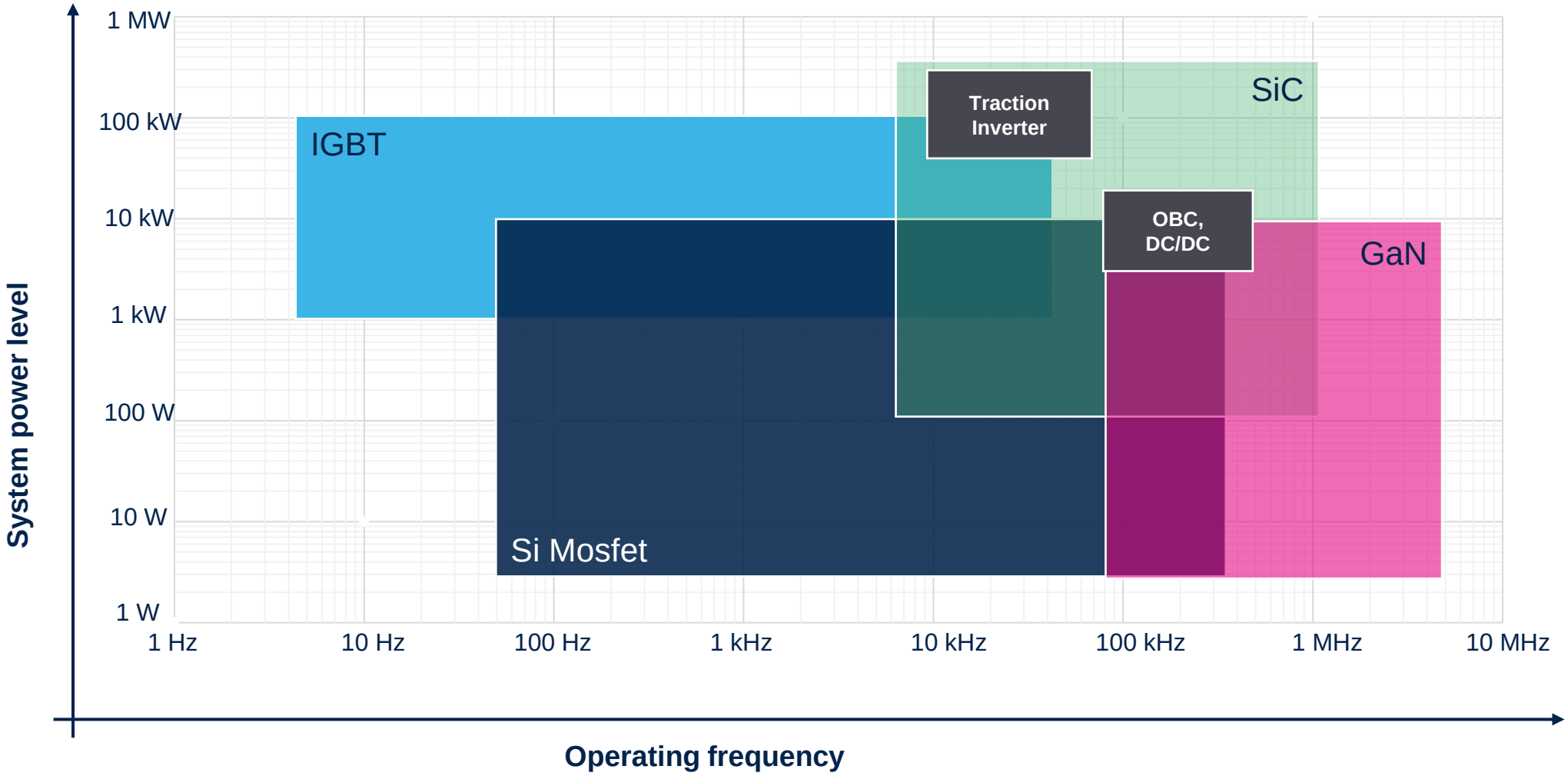


Inverter

Power pack + housing + connectors

SiC value proposition

Power technologies
Positioning versus the key applications



Silicon Carbide (SiC) history

More than 20 years of SiC history in STMicroelectronics

1891 — Silicon carbide was discovered by Edward G. Acheson in 1891. He named it Carborundum

1905 — Henri Moissan discovered SiC grains in the Diablo Canyon iron meteorite

1951 — 1949-1951 Frank developed the screw dislocation theory of polytypism

1958 — 1958 First SiC conference held in Boston, USA.

1996 — June 1996: Collaboration with Physics Dept.

2003 — February 2003: ETC Epitaxial reactor prototype installed in ST

2004 — May 2004: Schottky Diode Demonstrator

2006 — October 2007: 1st Gen Diode Start Production

2008 — March 2009: Power MOSFET 3" Demonstrator

2010 — May 2012: 2nd Gen Diode Start Production

2012 — September 2014: 1st Gen MOSFET Start Production

2014 — June 2014: 3rd Gen 3 Diode Start Production

2016… — June 2017: 2nd Gen MOSFET Start Production

1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016…

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Silicon carbide is ideal for high-power applications

Reliability at higher temperatures and cooling system size and cost are major concerns in high-power applications

3x higher thermal conductivity than Si	3x higher bandgap than Si equates to 10x higher breakdown field	
High current density	Fast switching	Low Rdson
High temperature operation	System size and weight reduction	Lower conduction & switching losses

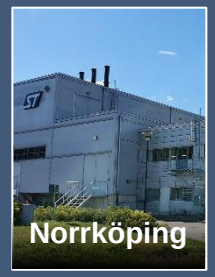
Investing in vertically integrated SiC manufacturing

Leading market position

In volume production with SiC devices since 2007

- More than 500 million devices shipped to automotive and industrial customers
- Qualification of 200 mm wafer fabrication in 2023
- A vertical integration strategy

Substrate | **Front-end** | **Back-end**



Future expansions

Catania

ST Silicon Carbide Campus
World's first fully integrated silicon carbide facility

Production to start in **2026** and **full build-out** in **2033**

Projected **5-billion-euro** multiyear investment program

Chongqing

ST and Sanan Joint Venture for SiC device manufacturing in China

安意法半导体有限公司
Sanan-ST Microelectronics Co. Ltd.

Production to start in **Q4 2025** and **full buildout** in **2028**

Total amount for full buildout expected to be **~3.2 billion dollars**

Vertically integrating for supply chain robustness

Raw material → SiC ingots & substrates → SiC dice manufacturing → discrete/module design & manufacture → Finished products

Norrköping SiC substrate R&D plant

- 150 mm production
- 200 mm with industrial quality and yields

Catania world's first fully integrated SiC facility

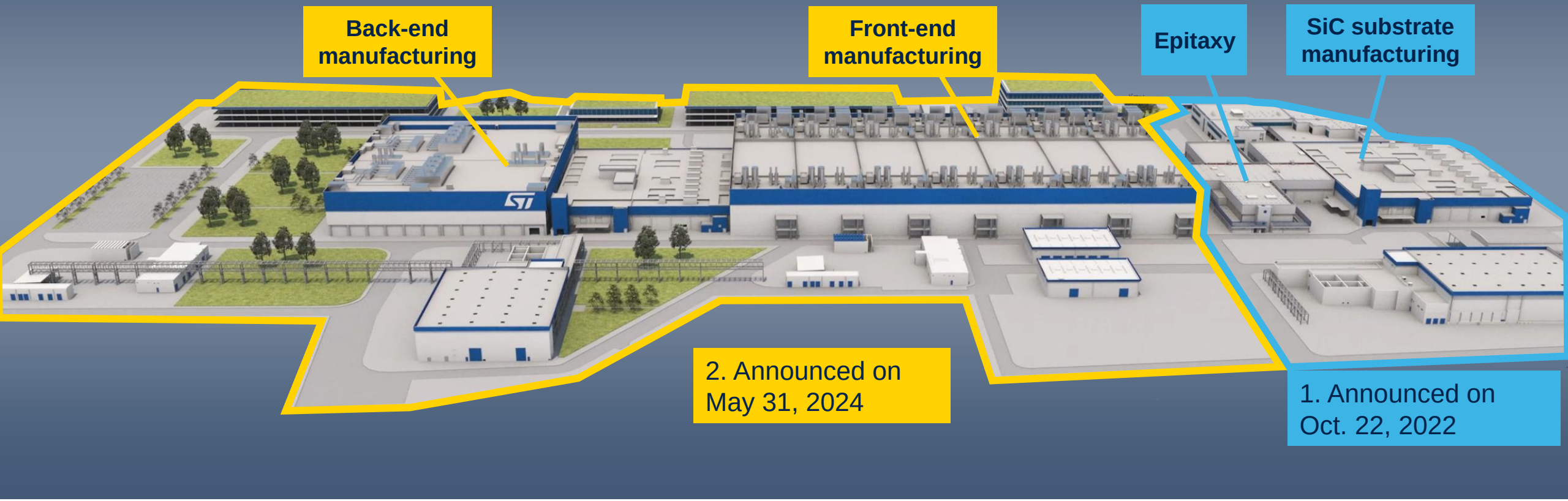
Architectural rendering of completed campus

SiC Campus: substrate + epitaxy + F-E + B-E

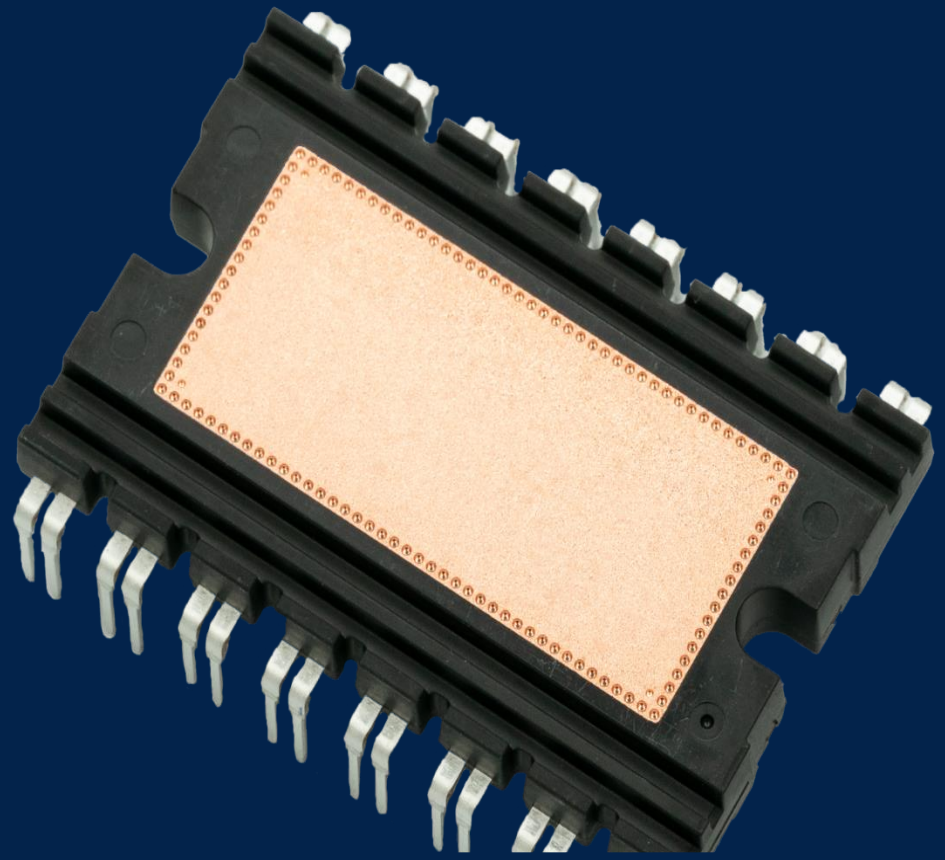
SiC substrate pilot product started in 2023

ST Silicon Carbide Campus in Catania

Vertically integrated silicon carbide facility



ACEPACK DMT-32 for EV/HEV automotive applications



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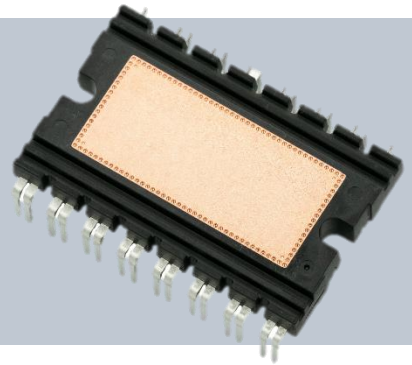
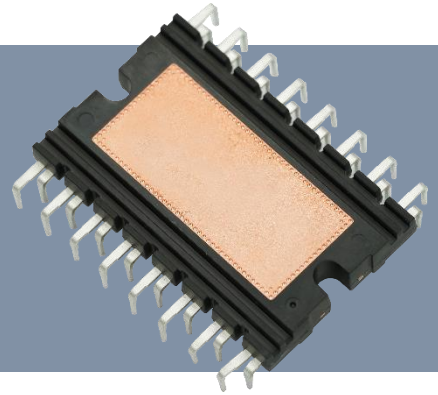
ACEPACK DMT-32 outline options

Inline



Package size
44 x 32.1 x 6 mm

Zig-zag



Package size
44 x 37.9 x 6 mm

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ACEPACK DMT-32

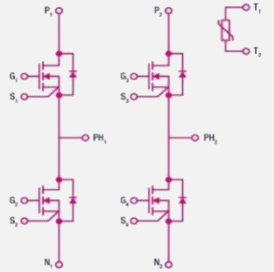
1200V SiC Gen2 power modules, Si-based* bridge diode rectifier

Topology	Part number	Dice	Pin option	$R_{DS(on)}$ typ (per switch)	DBC	ES	QS(1)	SOP
Fourpack (Dual half-bridge)	M1F80M12W2-1LA	SiC	Inline	80 mΩ	AlN	-	-	MP
	M1F45M12W2-1LA	SiC	Inline	45 mΩ	AlN	-	-	MP
3-phase four-wire PFC	M1TP80M12W2-2LA	SiC & Si*	Inline	80 mΩ	AlN	-	Now	Apr 25
	M2TP80M12W2-2LA	SiC & Si*	Zig-zag	80 mΩ	AlN	-	Now	Apr 25
Sixpack	M1P45M12W2-1LA	SiC	Inline	45 mΩ	AlN	-	-	MP
	M2P45M12W2-1LA	SiC	Zig-zag	45 mΩ	AlN	-	Now	Apr 25

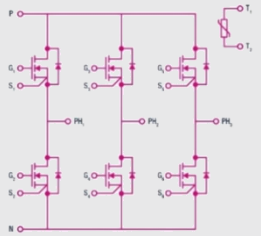
Inline

Zig-zag

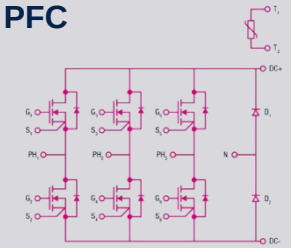
Fourpack
(Dual half-bridge)



Sixpack



3-phase four-wire PFC



As of Mar 2025; timelines may be subject to change without prior notification
*Si diodes in totem pole configuration
(1) Lead time applies

ACEPACK DMT-32

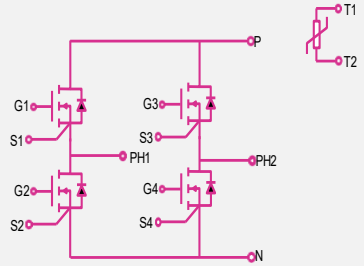
1200V and 650V SiC Gen3 based power modules

Zig-zag

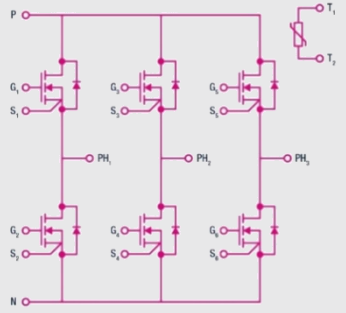
BV	Topology	Part number	Pin option	$R_{DS(on)}$ typ (per switch)	DBC	ES(1,2)	QS(2)	SOP
1200 V	Fourpack (Full-bridge)	M2F40M12W3-2LA	Zig-zag	40 mΩ	AlN	Jun 25	Sep 25	Nov 25
		M2F30M12W3-2LA	Zig-zag	27.5 mΩ	AlN	May 25	Aug 25	Oct 25
	Sixpack	M2P70M12W3-1LA	Zig-zag	70 mΩ	AlN	Jun 25	Sep 25	Nov 25
		M2P40M12W3-1LA	Zig-zag	40 mΩ	AlN	May 25	Aug 25	Oct 25
	Fourpack + half-bridge	M2FH32M12W3-1LA	Zig-zag	4x30 + 2x20 mΩ	AlN	May 25	Aug 25	Oct 25

BV	Topology	Part number	Pin option	$R_{DS(on)}$ typ (per switch)	DBC	ES(1,2)	QS(2)	SOP
650 V	Sixpack	M2P20M65W3-1LA	Zig-zag	20 mΩ	AlN	Apr 25	Jun 25	Jul 25

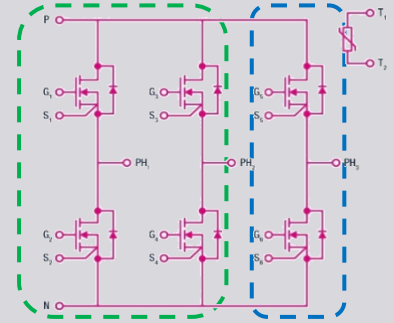
Fourpack
(Full bridge)



Sixpack



Fourpack + half-bridge



As of Mar 2025; timelines may be subject to change without prior notification
Limited qty
Lead time applies

ACEPACK DRIVE

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Direct liquid cooled high-performance power module

Traction inverter for (H)EV, trucks, and buses

Main traction inverter

Press fit connections for high reliable and long-lasting connection

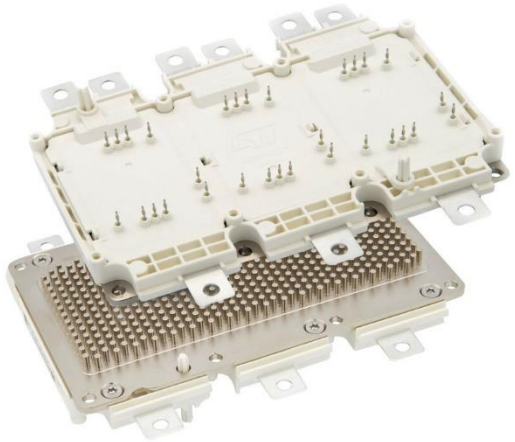
AQG-324 qualified

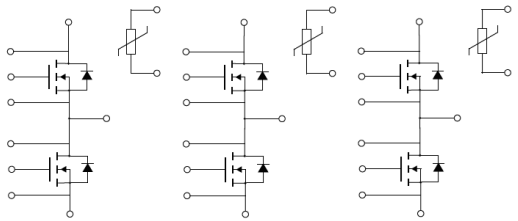
Pin-fin base plate for direct liquid cooling

Dedicated NTC for each single substrate

Best-in-class $R_{DS(on)}$

ACEPACK DRIVE
based on
SiC MOSFET Gen3
1200 & 750 V





Internal layout optimized for minimized stray inductance

High reliability and robustness: dice sintered to substrate for SiC-based power modules

Different bus bar available to fit welding or screwing connection methods

AMB substrates for better thermal management for SiC-based power modules

Extremely high-power density

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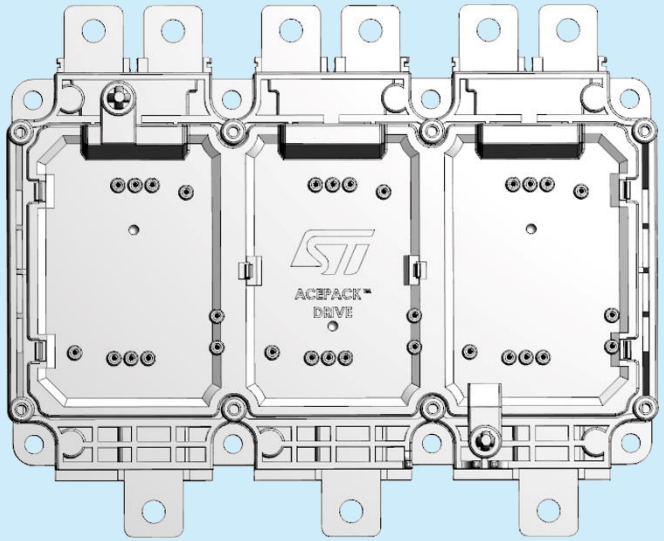
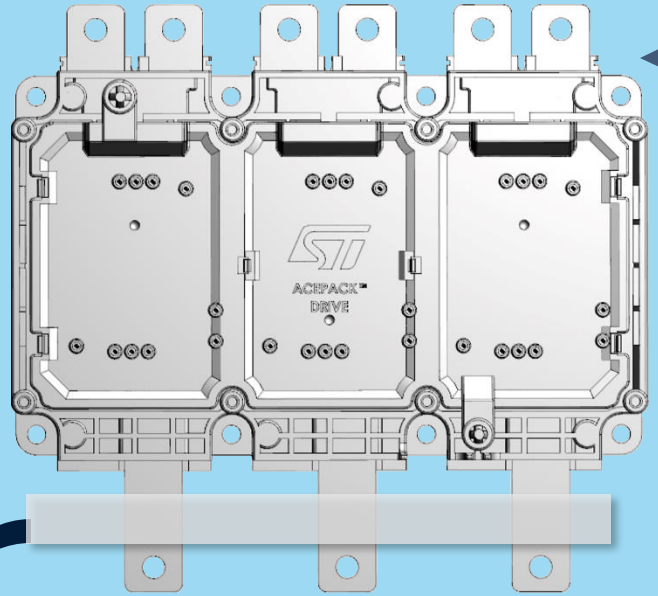
ACEPACK DRIVE bus bar option

Short tab option



Long tab option

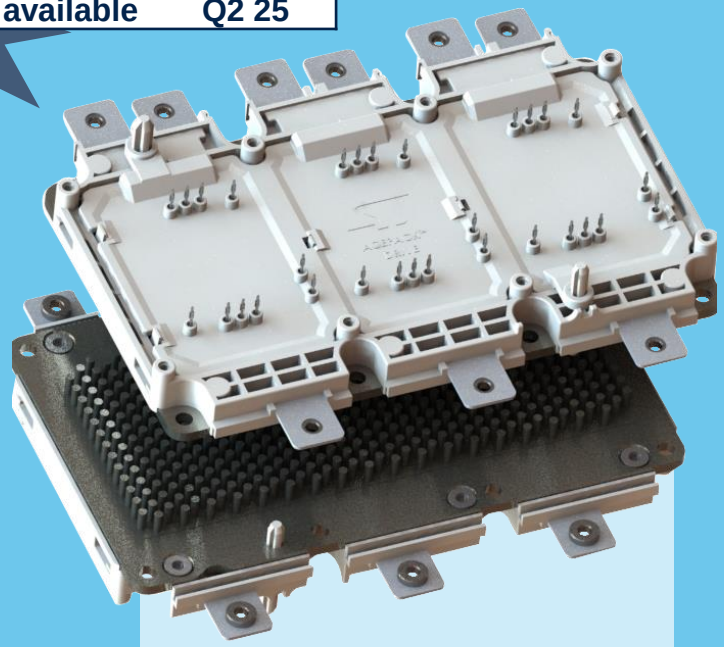


To apply a Hall current sensor from the HAH3DR family

Short tab with self-clinching nuts

Coming soon

ES*	Production
available	Q2 25

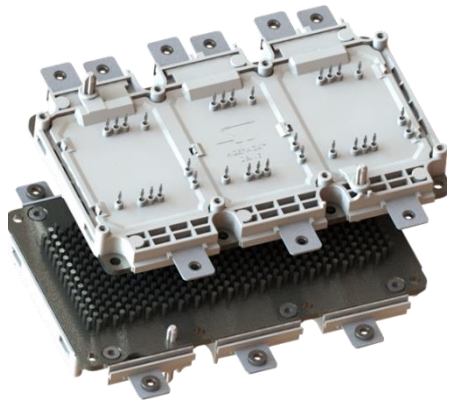


- Compatible with M4 screws
- Easier connection with DC link and motor tabs

*Lead time applies

SiC-based ACEPACK DRIVE
Product portfolio in full production

Fully powered with ST Gen3 SiC MOSFETs



Part number	SiC technology	BV	$R_{DS(on)typ}$ @ 25°C (per switch)	$R_{DS(on)typ}$ @ 175°C (per switch)	Max peak power indication(1)
ADP480120W3(-L)	Gen3	1200 V	1.90 mΩ	3.35 mΩ	**300 kW**
ADP360120W3			2.55 mΩ	4.25 mΩ	**230 kW**
ADP280120W3			3.80 mΩ	6.50 mΩ	**180 kW**
ADP61075W3(-L)		750 V	1.20 mΩ	1.95 mΩ	**220 kW**
ADP46075W3			1.60 mΩ	2.60 mΩ	**175 kW**

www.st.com/en/power-modules-and-ipm/acepack-drive/products.html

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1. Power level coming from simulation, system power depending on inverter design and mission profile

Transfer molded modules

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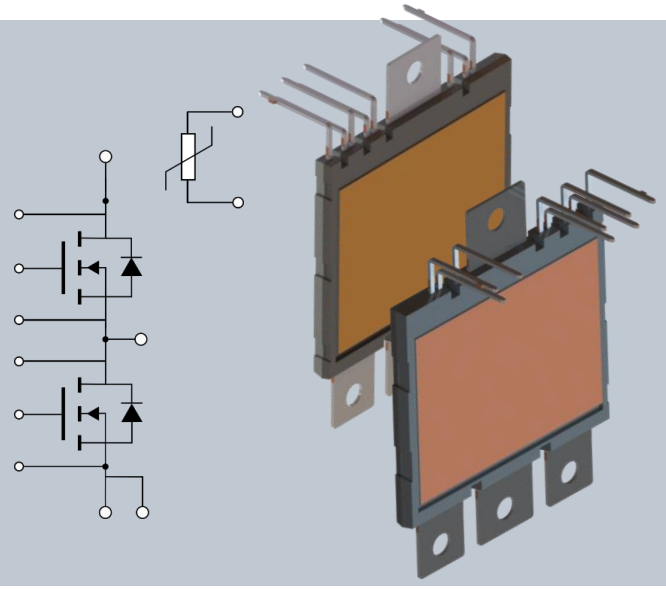
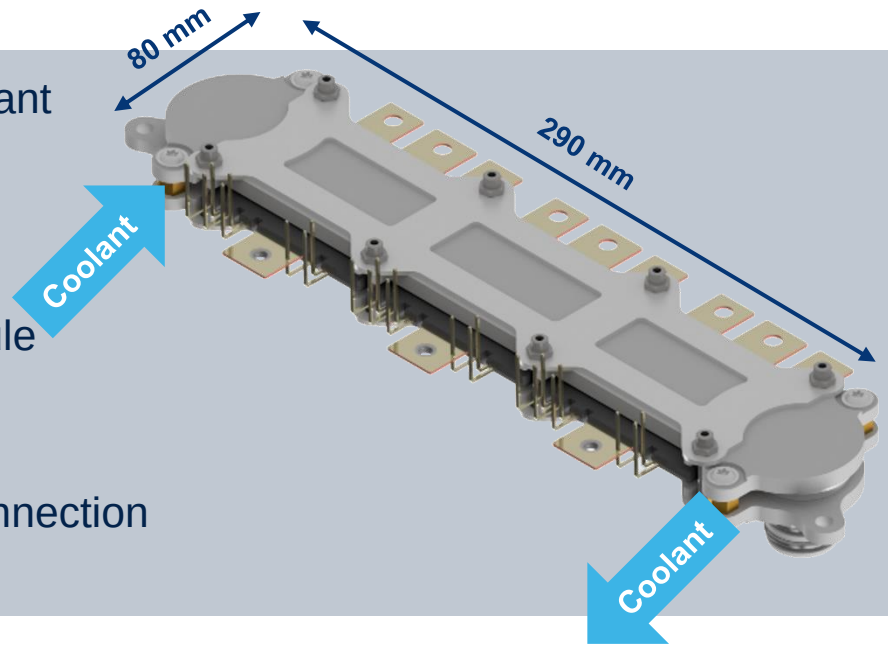
In development
ACEPACK Gemini

1200 V blocking voltage and ultralow 4 nH stray inductance for (H)EV traction inverter applications



- Automotive module AQG324 compliant
- Maximum T_J = 175°C
- High performance Si_3N_4 ceramic
- High power and current density
- Double-sided indirectly cooled module
- High reliability & robustness
- Signal pins: frame pins
- Full sintered stack layers for interconnection
- Integrated NTC temperature sensor



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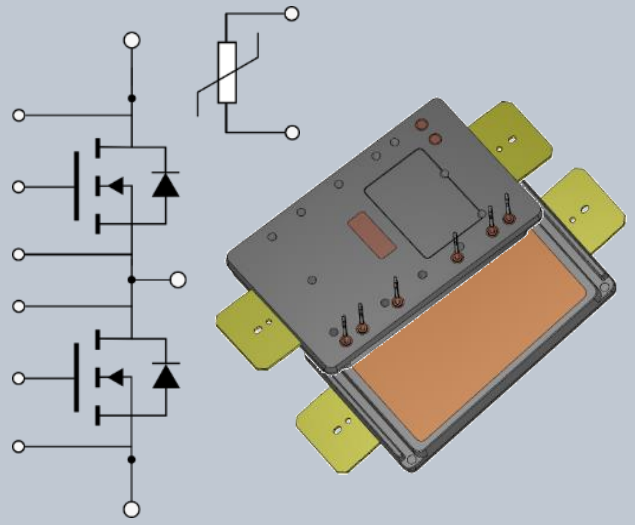
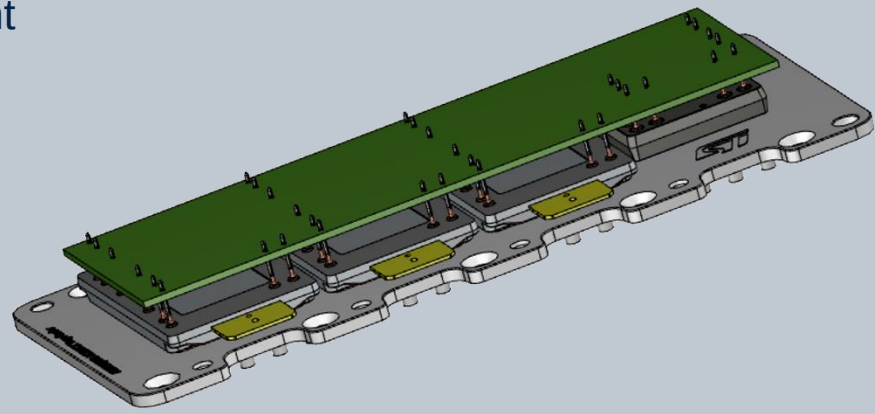
In development
ACEPACK Vega

750 & 1200 V blocking voltage in most compact package for (H)EV traction inverter applications



- Automotive module AQG324 compliant
- Low stray inductance of 6 nH
- Maximum TJ = 175°C
- High performance Si3N4 ceramic
- High power and current density
- High reliability & robustness
- Pin on top
- Clip for internal interconnections
- Full sintered stack layers for interconnection
- Optional: integrated NTC temperature sensor



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Our technology starts with You

Find out more at www.st.com

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