



# Shaping future electromobility with semiconductor innovations

Semiconductor solutions for hybrid electric and electric cars



## A vision built on semiconductors

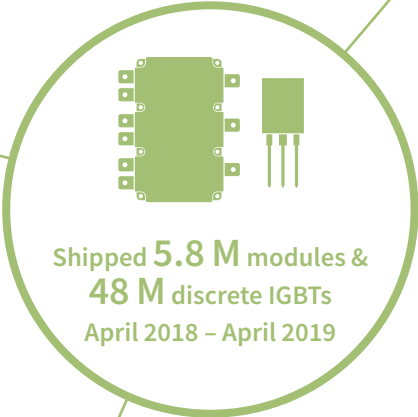
Resource scarcity, climate change and growing energy demands accentuate the need for sustainable mobility choices worldwide. The answer lies in low- and zero-carbon electromobility concepts that are fit for the future. A climate-friendly mobility ecosystem hinges, however, on energy efficiency across the entire power chain – from generation through distribution right up to the point of use.

Semiconductors are the key enablers behind a sustainable mobility vision. They play a vital role in building energy efficiency into all steps of the energy supply chain, and build the basis for electrifying a broad range of different vehicles for a greener future.

# Experience matters

Here at Infineon, we have a long and proven track record in the delivery of innovations at the heart of the emerging electric infrastructure. Building on our extensive and continued research, an expert understanding of design

needs at system level and an exceptionally broad product portfolio serving a wide customer base, we are firmly committed to building more sustainability into the entire mobility landscape.



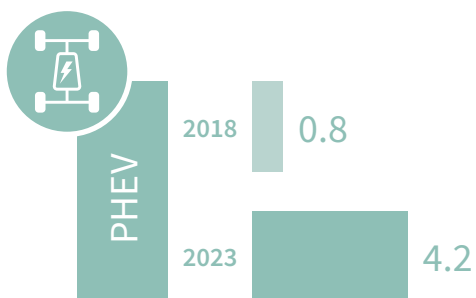
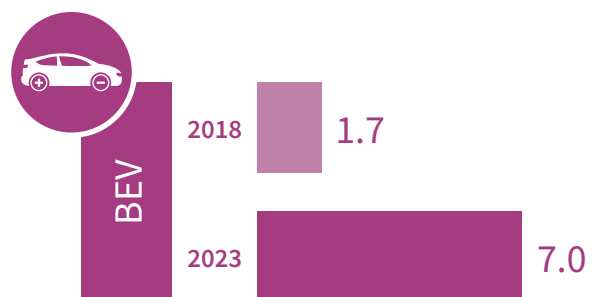
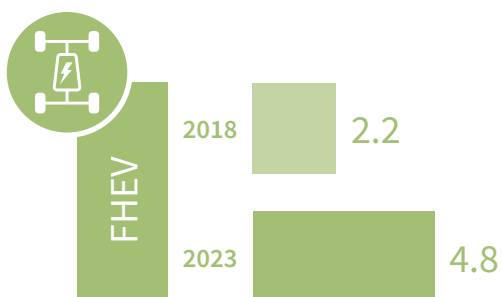


## Committed to the future

The fast-growing adoption of electrified vehicles (EVs) and increasingly rapid build-out of the enabling charging infrastructure present their own logistical challenges. These can only be met by a trusted, experienced, committed semiconductor supplier with the innovative strength, volume capabilities and market reach needed for widespread

EV commercialization. Which is why we are expanding our current Villach site with a new, fully automated 300 mm chip factory dedicated to research and production of the energy-saving chips needed to support the rapidly expanding EV market.

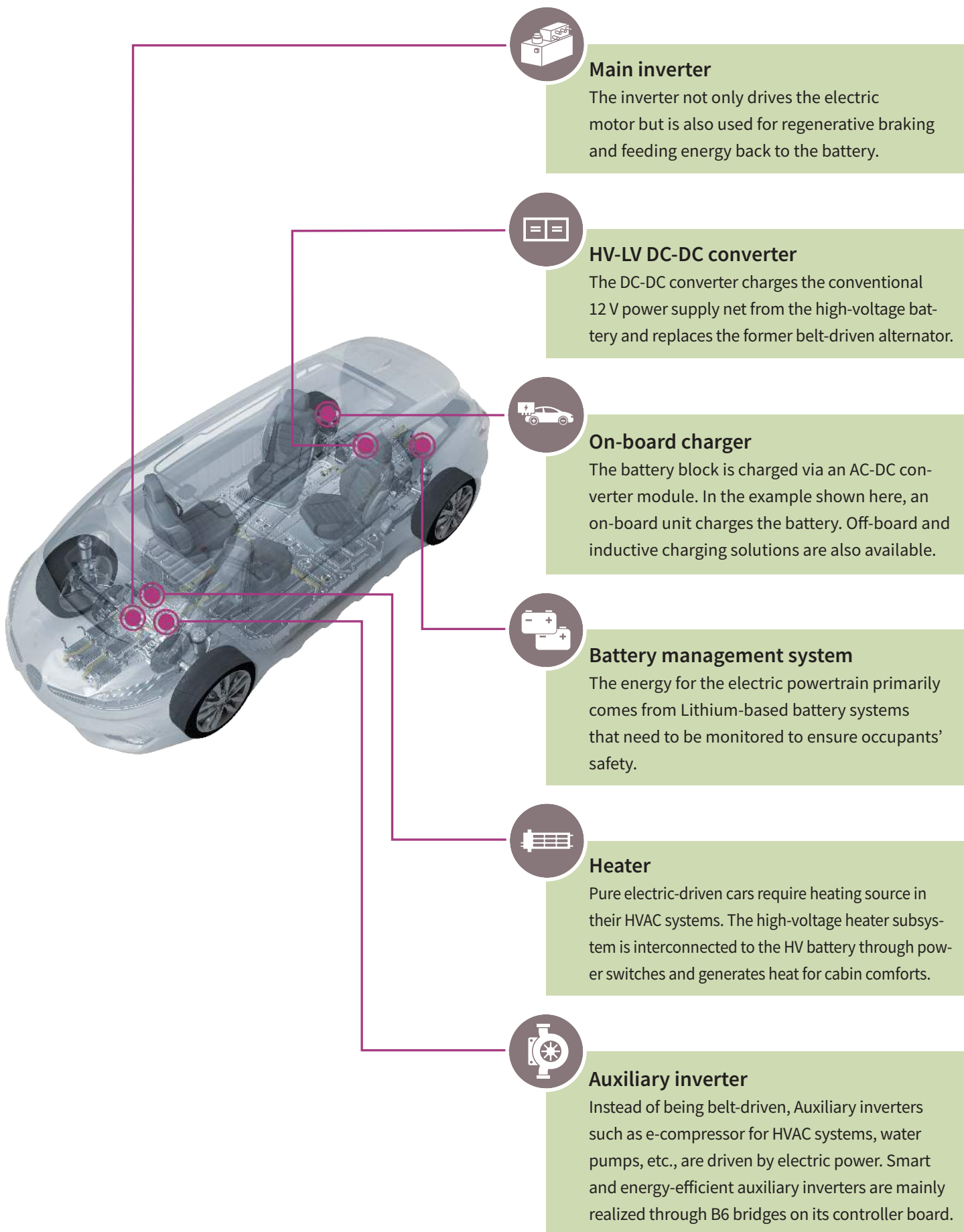
xEV volumes will rise significantly by 2023\*



FHEV: Full hybrid  
 PHEV: Plug-in hybrid  
 BEV: Battery electric vehicle  
 MHEV 48V: Mild hybrid electric vehicle 48V

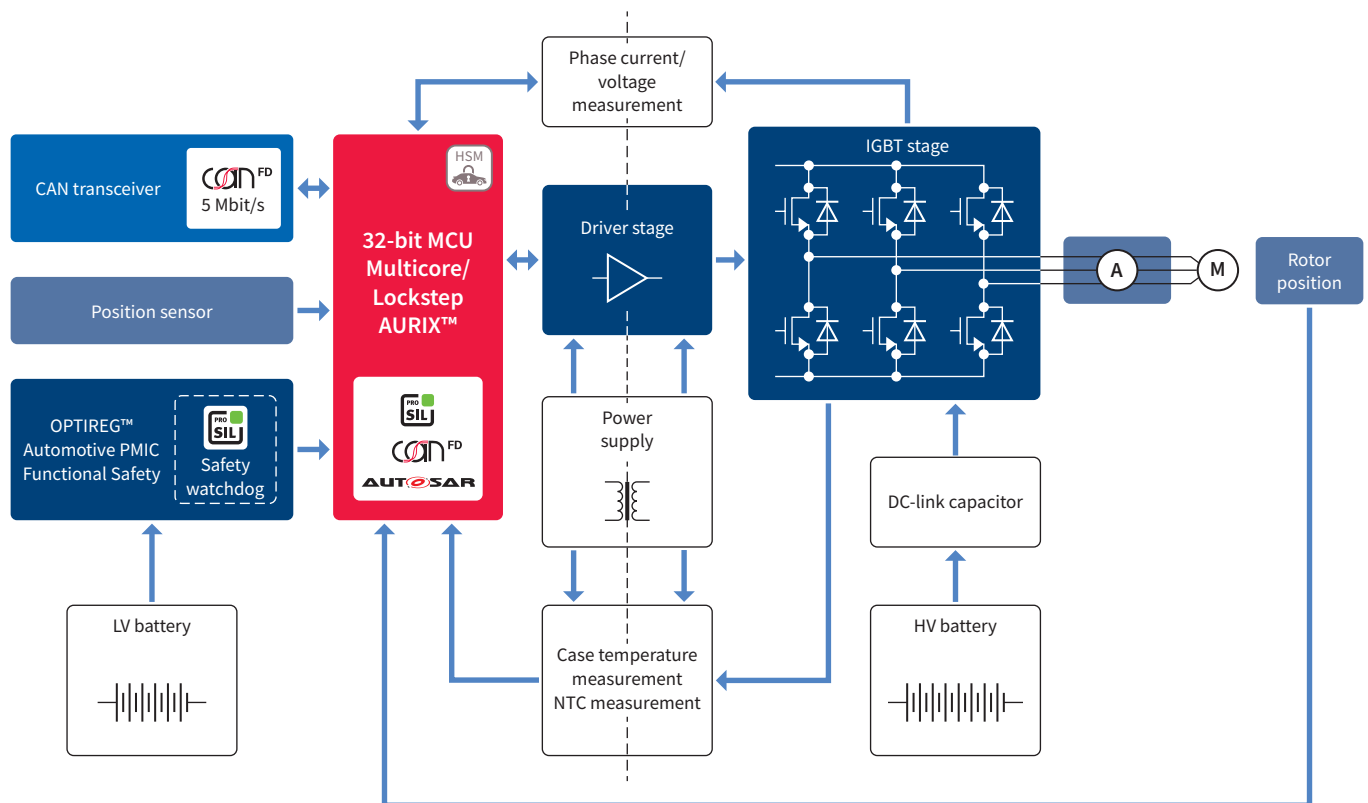
\* Cars (million units)  
 IHS Markit, March 2019.  
 Information is not an endorsement of Infineon Technologies AG. Any reliance on these results is at the third party's own risk. Visit [technology.ihs.com](https://www.technology.ihs.com) for more details.

# Application overview



# Main inverter

The inverter controls the electric motor. This is a key component in electric cars as, similar to the Engine Management System (EMS) of combustion vehicles, it determines the driving behaviour. Regardless of whether the motor is synchronous, asynchronous or brushless DC, the inverter always functions in a similar way and is controlled by an integrated PCB, which should be designed to minimize switching losses and maximize thermal efficiency. Not only does the inverter drive the electric motor, but it also captures the energy released via regenerative braking and feeds it back to the battery. As a result, the range of the vehicle is directly related to the efficiency of the main inverter.



## System benefits

- > Fully automotive-qualified power semiconductor portfolio including both power module and discrete solutions for flexible coverage of all motors, generators and power classes
- > Highly efficient 3-phase driver thanks to very low conduction losses even at high switching frequencies
- > Isolation integrated in gate driver
- > Scalable 32-bit microcontroller AURIX™ family for main inverter applications with highly cost-effective resolver interface, accelerators for improving system efficiency and performance, and enabling ASIL-D systems
- > OPTIREG™ automotive PMIC multi-rail, safety power supply combined with AURIX™ microcontroller to enable functional safety
- > Main inverter evaluation kit available to reduce system development time
- > Magnetic position sensors for high precision motor control



## Our semiconductor solutions for the main inverter

Our highly reliable semiconductor solutions support a wide range of motors, generators and power classes, enabling compact and cost-efficient system designs that offer high energy efficiency thanks to the reduction of power losses. Highlights include:

**HybridPACK™ power modules**  
Our HybridPACK™ family enables a smooth transition across all power classes from HEV to EV (from 10 kW to 175 kW). These integrated power modules contain all power semiconductors required to drive electric motors of up to 175 kW, with the added bonus of compact inverter designs and optimum support for water cooling.

**Automotive IGBT discret es**  
High-efficiency, low-loss IGBT discret es bundle our outstanding trench- and fieldstop technologies to reduce saturation voltages well below the levels offered by competing standard NPT IGBTs – without increasing the switching losses. These IGBT discret es offer maximum flexibility and scalability when it comes to the application design, for all power classes.

**Driver ICs**  
The Infineon® EiceDRIVER™ family includes single and dual-channel automotive IGBT driver ICs that provide galvanic isolation and bidirectional signal transmission. These products are ideal for the main inverter systems in automotive applications where efficiency, space savings and monitoring functions are priorities.

**Microcontroller**  
The scalable 32-bit microcontroller AURIX™ family is the perfect brain for energy efficient drivetrains by combining superior performance, ASIL-D supportive functions and integrated resolver-to-digital interface.

**XENSIV™ sensors**  
Our position sensors enable close-loop feedback of the motor position for Field-Oriented Control (FOC) that supports the highest safety levels. Our XENSIV™ angle sensors measure the rotor position of the electric motor.

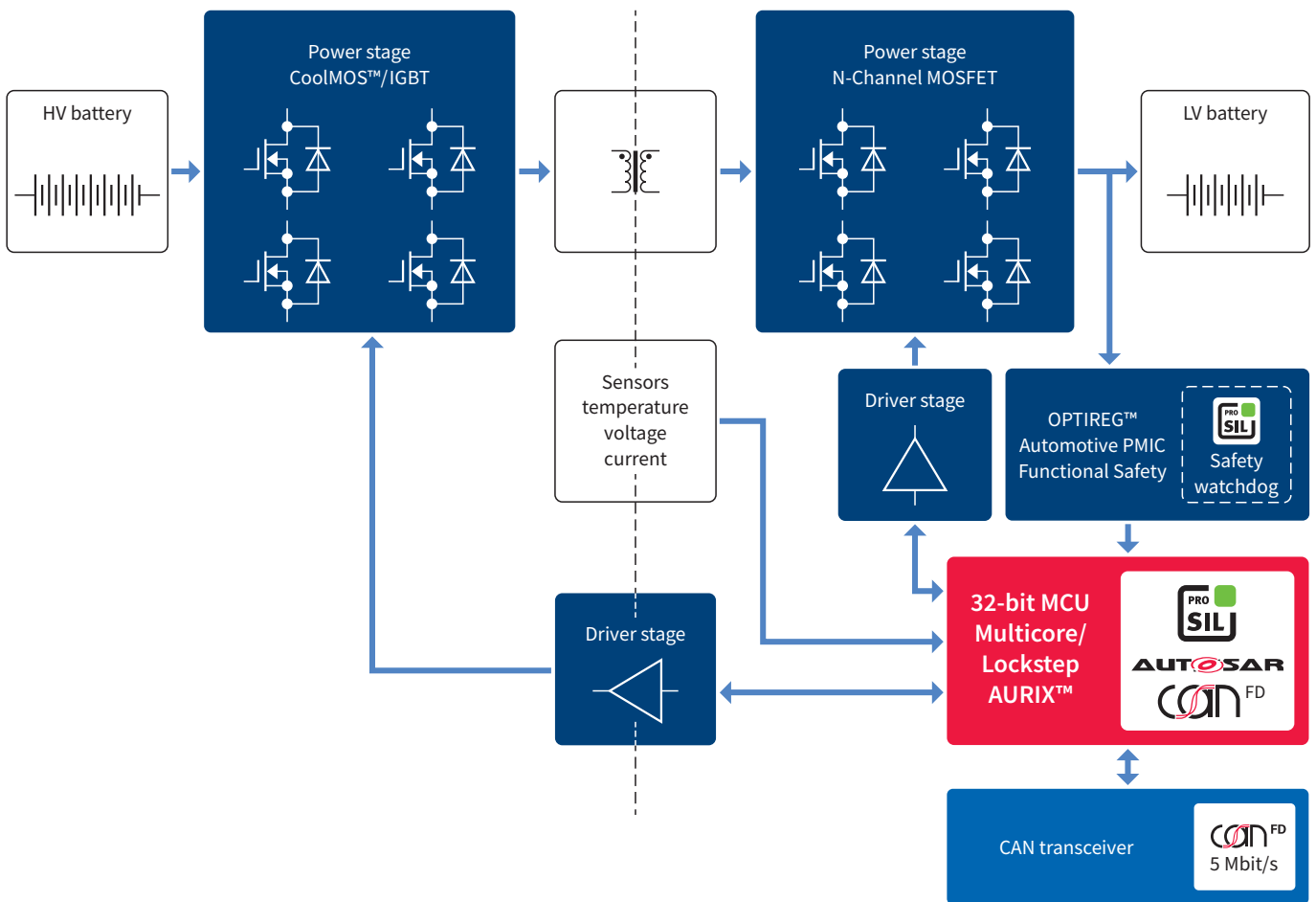
**Power management IC**  
OPTIREG™ automotive PMIC: ISO26262-compliant, multi-rail power supply with microcontroller-, communication-, and sensor- supply rails and monitoring/supervisory functions (PRO-SIL™).

**Power management IC**  
TLE9252V, a 14-pin automotive transceiver designed for HS CAN networks with Flexible Data-rate up to 5 Mbit/s in automotive and industrial applications. The dual power supply concept (state machine supplied by  $V_{BAT}$  „or“  $V_{CC}$ ) avoids disruption of communication during  $V_{BAT}$  cranking.

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# HV-LV DC-DC converter

Different voltage levels are required by the various electronic components in an EV. High-voltage batteries with different voltage levels are currently available on the market. In addition, the power classes scale from 1 kW to 5 kW depending on the number of low-voltage applications. In the past, the alternator was used to supply the 12 V power supply system. In EVs and HEVs, the DC-DC converter supplies the 12 V power system from the high-voltage battery. Designers are called on to increase the conversion efficiency as a way of extending the range of the vehicle. Furthermore, different components may be required depending on whether the design is geared toward a uni- or bidirectional energy transfer.



## System benefits

- > Fully automotive-qualified product portfolio including both power module and discrete solutions
- > Supports a wide range of highly efficient conversion topologies (including bidirectional)
- > Compact design with the highest power density
- > Very low switching losses at high switching frequencies
- > Isolation integrated in gate driver
- > 32-bit multicore microcontrollers enabling sub-system integration (PFC + DC-DC control)
- > OPTIREG™ automotive PMIC includes functions for functional safety and enables power supply of complete system
- > Automotive standard communication (CAN)
- > Evaluation kit available to reduce system development time





## Our semiconductor solutions for the DC-DC converter

Our chip solutions enable designers to build small DC-DC converters with a high power density, thereby supporting all voltage and power classes. Highlights include:

**MOSFET**  
CoolMOS™ transistors for the high-voltage side – this MOSFET is based on our superjunction technology, ensuring a low  $R_{DS(on)}$  at high switching frequencies.

**Automotive EasyPACK™ power module**  
Our EasyPACK™ automotive power modules with a high-speed IGBT3 and rapid diode enable a compact design and the highest energy efficiency ratings for converters from about 2–10 kW.

**Driver ICs**  
The EiceDRIVER™ family includes single and dual-channel automotive IGBT driver ICs that provide galvanic isolation and bidirectional signal transmission. These products significantly reduce the space requirements on the control board. Our automotive-qualified gate driver ICs help simplify design and optimize performance in all FETs and IGBTs driving stages.

**Microcontroller**  
Thanks to its multicore architecture, our highly scalable 32-bit microcontroller AURIX™ family enables sub-system integration e.g. PFC + DC-DC control, thereby reducing the design-in effort.

**Power management IC**  
TLE4997/TLE4998 family of XENSIV™ linear Hall sensors allow high precision current measurement by integrating them into a closed loop current measurement.

**Automotive IGBT discret es**  
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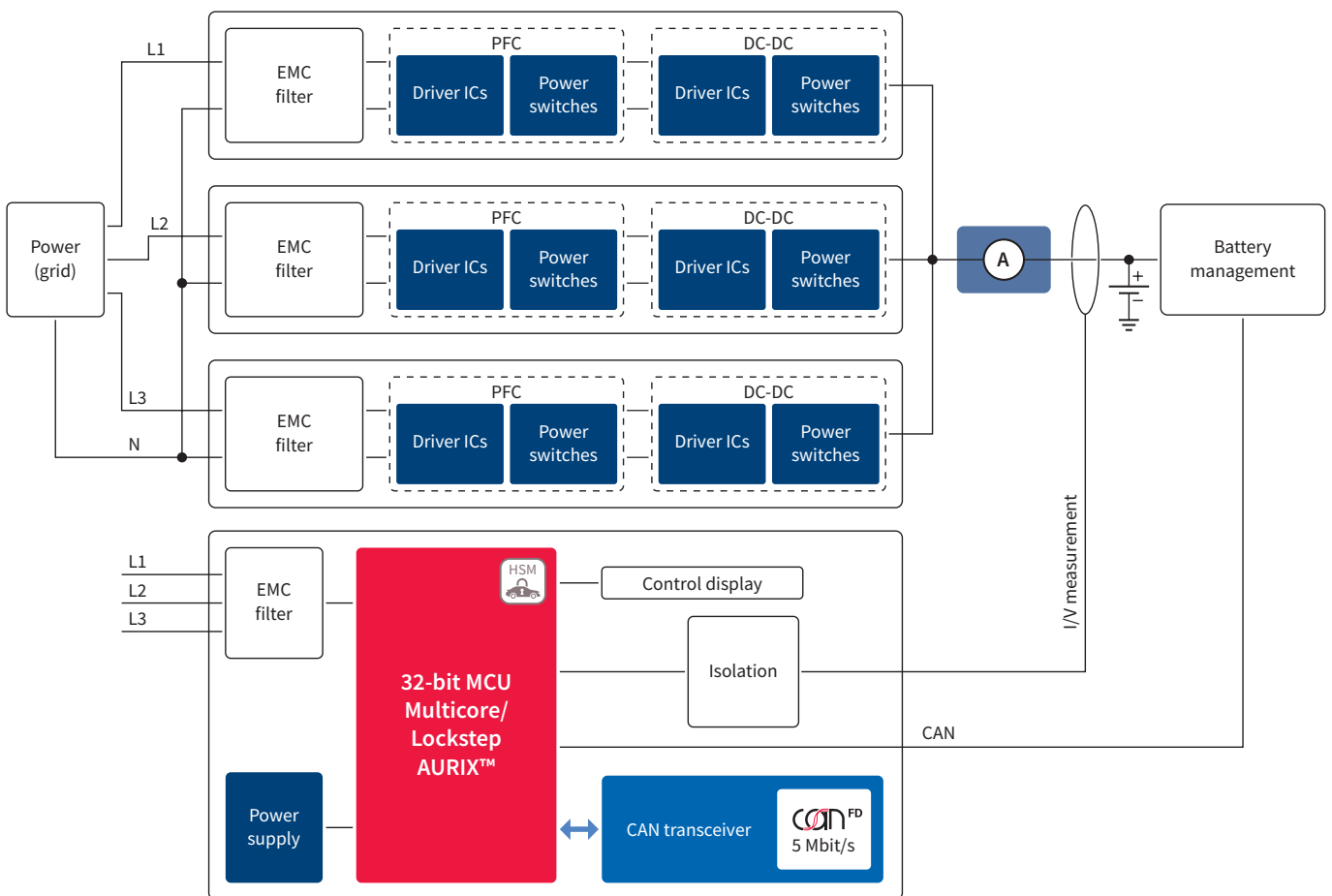
**Power management IC**  
Multi-rail power supply optimized for system supply and functional safety.

**Power management IC**  
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# On-board charger

The battery in an electric vehicle is useless without a battery charger. Furthermore, all electronic systems depend on the battery for power. In battery electrical vehicles and plug-in hybrid electrical vehicles, the battery can be charged from a standard power outlet. Charging via the main grid calls for design flexibility due to the different voltage and current levels in different countries. And needless to say, the charging time is also an important factor for car drivers. System designers face the challenge of supporting the varied voltage and current levels while increasing the power density. When it comes to on-board charging, the key success factors involve efficiency and a high power density for a small form factor. The long-term trend is moving towards bi-directional charging, where the charger also feeds power from the car to the smart grid.



## System benefits

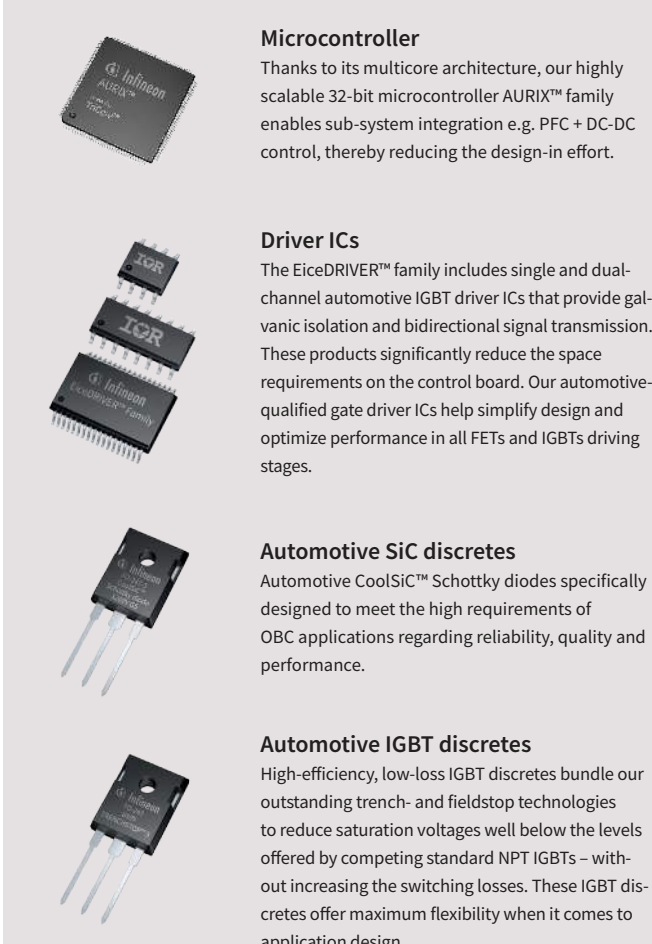
- > Suitable for plug-in hybrids and battery electrical vehicles
- > Adjustable current limits
- > Integrated Power Factor Correction (PFC)
- > Automotive standard communication (CAN)
- > Galvanic isolation
- > Modular concept enables 1 to 3-phase AC power supply
- > Wide range of power switches from CoolMOS™ to automotive IGBT discretes and EasyPACK™ power modules

Looking for Off-board charging semiconductor solutions, please visit our web-site: [www.infineon.com/ev-charging](http://www.infineon.com/ev-charging)



## Our semiconductor solutions for on-board chargers

Driver ICs the EiceDRIVER™ family includes single and dual-channel automotive IGBT driver ICs that provide galvanic isolation and bidirectional signal transmission. These products significantly reduce the space requirements on the control board. Our automotive-qualified gate driver ICs help simplify design and optimize performance in all FETs and IGBTs driving stages.




**Microcontroller**  
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**Automotive SiC discretes**  
Automotive CoolSiC™ Schottky diodes specifically designed to meet the high requirements of OBC applications regarding reliability, quality and performance.

**Automotive IGBT discretes**  
High-efficiency, low-loss IGBT discretes bundle our outstanding trench- and fieldstop technologies to reduce saturation voltages well below the levels offered by competing standard NPT IGBTs – without increasing the switching losses. These IGBT discretes offer maximum flexibility when it comes to application design.



**MOSFET**  
CoolMOS™ transistors – high-voltage automotive MOSFETs for low-power charging solutions (overnight).

**Automotive EasyPACK™ power module**  
EasyPACK™ 1B/2B – flexible power module solutions for low-power charging solutions.

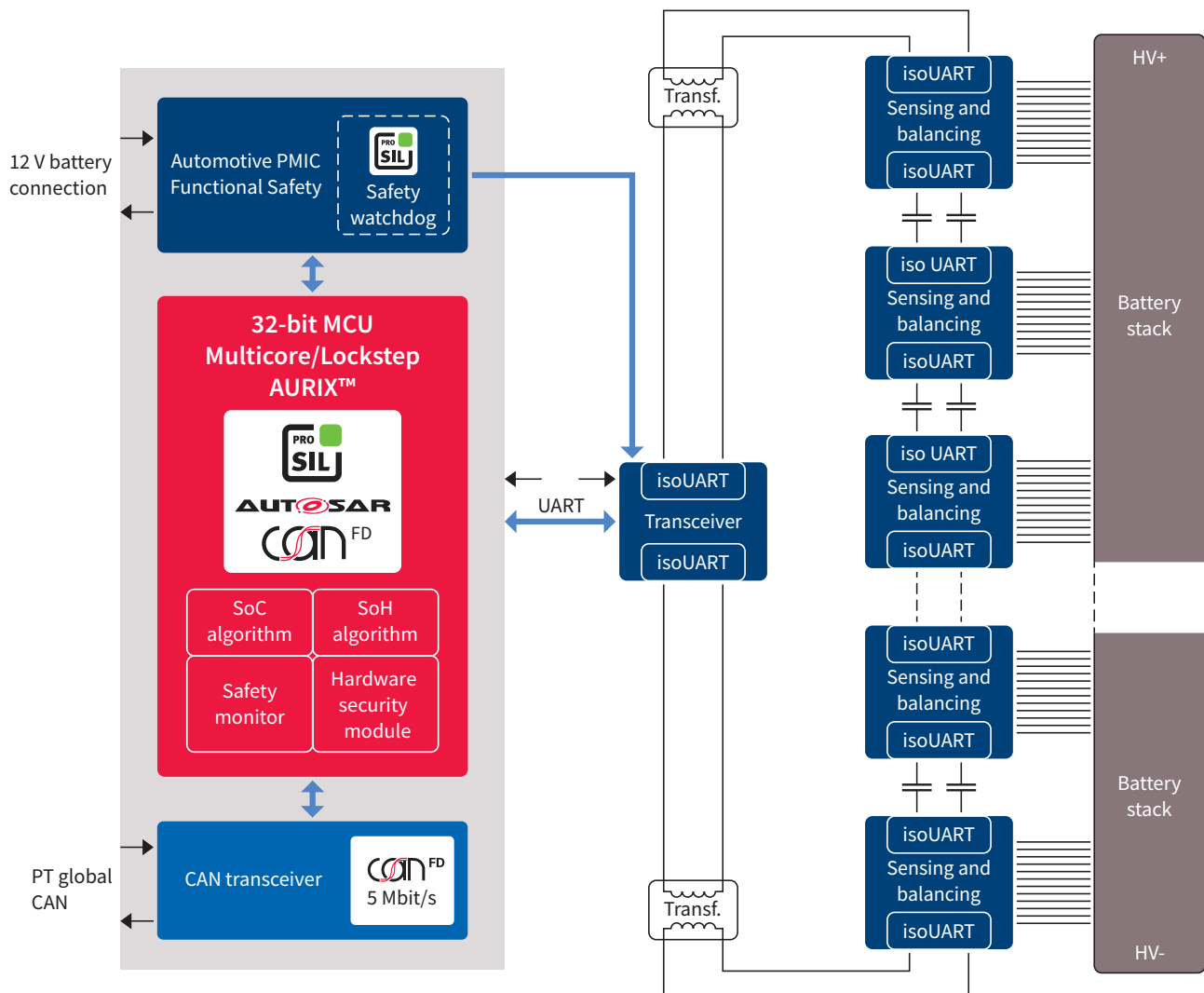
**Power management IC**  
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# Battery management system

The battery management system is in charge of monitoring each of the cells included in a battery pack and ensuring that they are operated within the safe operating range. It monitors and reacts to the State of Health (SoH), State of Charge (SoC) and Depth of Discharge (DoD) with the assistance of balancing ASICs. It is also able to operate under low-current consumption mode to ensure holiday parking. Furthermore, it prevents illegal manipulation of both the system and battery packs via integrated security on the AURIX™ microcontroller.



## System benefits

- > Fully automotive-qualified product portfolio offering the full pallet of products from a single source
- > Enhanced security enabled by the integrated hardware security module (AURIX™ HSM)
- > Compatible communication protocol from microcontroller due to sensing ICs
- > Common safety concept for microcontroller and power supply
- > Integrated standby controller in AURIX™
- > OPTIREG™ automotive PMIC multi-rail, safety power supply combined with AURIX™ to enable functional safety
- > Fully synchronized voltage measurement of all cells in the battery thanks to a low-latency IBCB communication bus and the ADC architecture of the sensing ICs
- > Capacitive-isolated communication contributes to reducing the system cost by avoiding transformers as well as common mode chokes
- > Integrated filtering facilitates the size reduction of external filter components



## Our semiconductor solutions for battery management



### Microcontroller

32-bit multicore TriCore™ microcontroller family, optimized for highly demanding powertrain applications (PRO-SIL™).



### Power management IC

OPTIREG™ automotive PMIC: ISO26262-compliant, multi-rail power supply with microcontroller-, communication-, and sensor-supply rails and monitoring/supervisory functions (PRO-SIL™).



### Power management IC

Battery management sensing IC offering 12-channel voltage measurement, 5 temperature sensor connections and a best-in-class communication protocol.



### Power management IC

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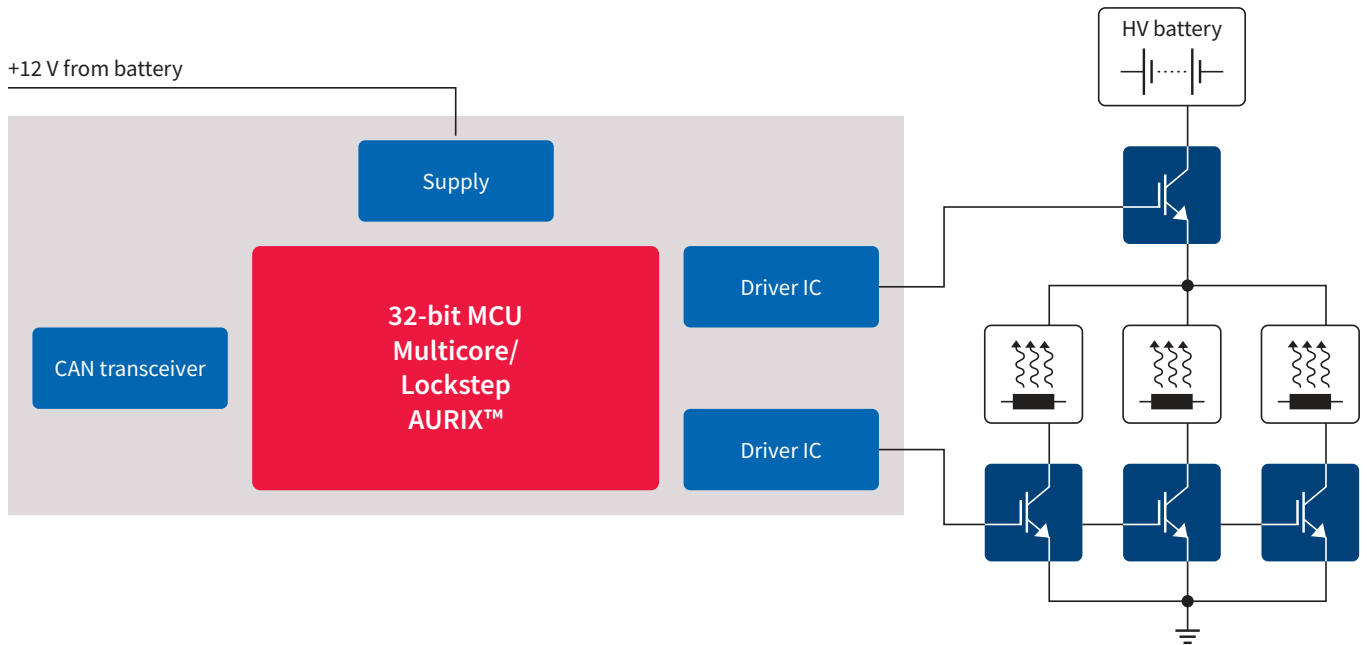


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# High-voltage heater

Pure electric-driven cars require heating source in their HVAC system. The high-voltage heater subsystem is interconnected to the HV battery through power switches. Due to strong cost pressure on this subsystem and high EMC requirements for the HV wire lines, the designers are challenged to achieve lowest system costs on a sufficient EMC level. Infineon semiconductor solutions help to optimize system costs and maximize its efficiency.




## System benefits

- > Automotive IGBT discrettes with slow-switching capability down-sizes EMC filters for lower system costs
- > Automotive IGBT discrettes with (top-side cooling) SMD packages helps to optimize manufacturing costs and system housing design




## Our semiconductor solutions for high-voltage heater

Driver ICs the EiceDRIVER™ family includes single and dual-channel automotive IGBT driver ICs that provide galvanic isolation and bidirectional signal transmission. These products significantly reduce the space requirements on the control board. Our automotive-qualified gate driver ICs help simplify design and optimize performance in all FETs and IGBTs driving stages.



**Driver ICs**  
Our automotive-qualified gate driver ICs help simplify design and optimize performance in all FET and IGBT driving stages.



**Microcontroller**  
The scalable 32-bit microcontroller AURIX™ family is the perfect brain for energy efficient drivetrains by combining superior performance, ASIL-D supportive functions and integrated resolver-to-digital interface.



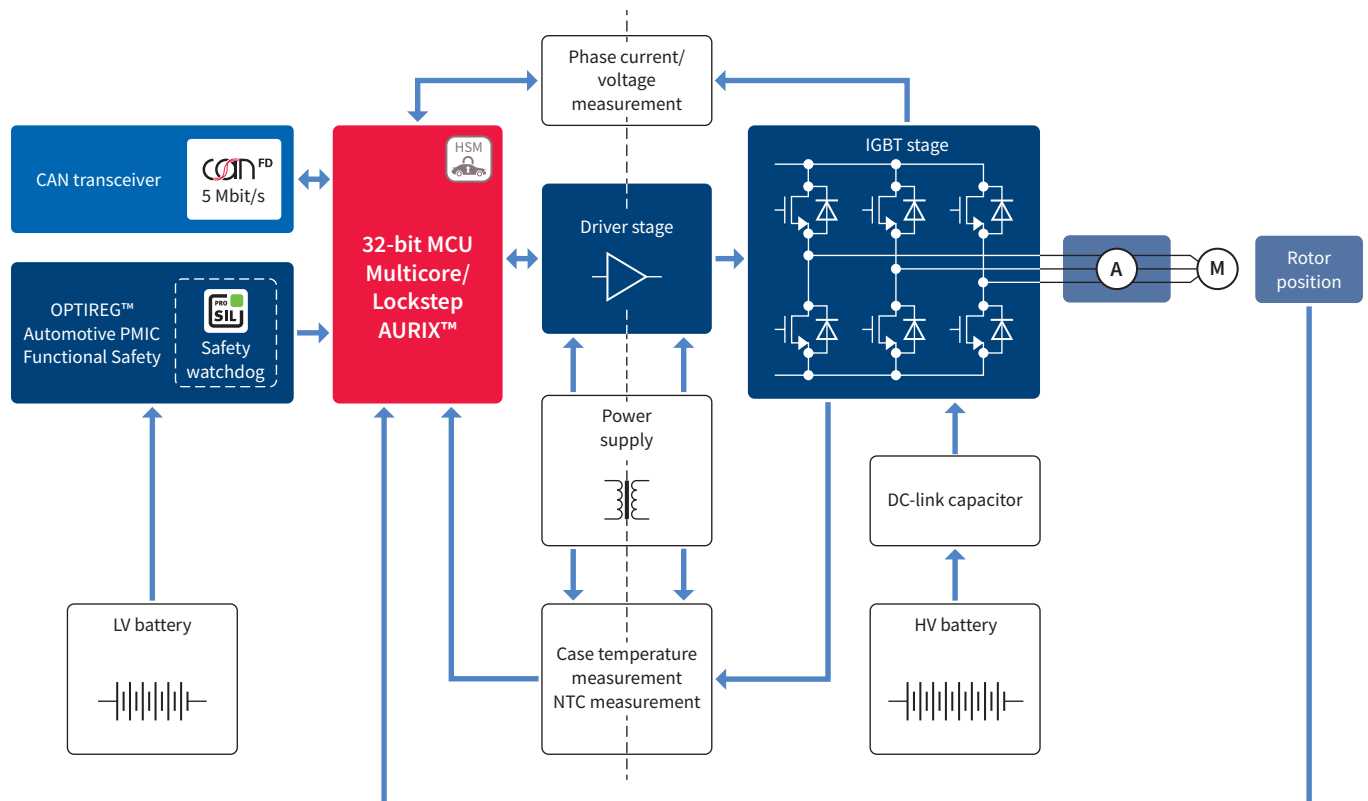
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# Auxiliary inverter

In HEVs and EVs, typical auxiliary systems (PTC heaters, auxiliary drives etc) are supplied via the high-voltage battery. Notably, the devices that were formerly belt-driven (such as the e-compressor for HVAC systems, oil pumps and cooling pumps) have now been electrified and integrated into the power system. These auxiliary inverters now deliver power on demand, thereby increasing the vehicle's energy efficiency. As power from the battery is expensive, the challenge is to use the electric power as efficiently as possible.



## System benefits

- > Automotive-qualified power semiconductor portfolio including both power module and discrete solutions for flexible coverage of all power classes
- > Highly efficient 3-phase driver thanks to very low conduction losses even at high switching frequencies
- > Isolation integrated in gate driver
- > Scalable 16- and 32-bit microcontroller solutions dedicated to drive (H)EV auxiliary motors
- > Multi-rail power supply for AURIX™ microcontroller
- > Evaluation kit available to reduce system development time
- > Magnetic position sensor for high precision motor control





## Our semiconductor solutions for the auxiliary inverter

Our fully automotive-qualified product portfolio supports a wide range of motors, generators and power classes, enabling compact designs that offer a high power density. Highlights include:




**Automotive EasyPACK™ power module**  
Our EasyPACK™ automotive power modules enable compact designs and the highest energy efficiency ratings for auxiliary drives and converters.




**Automotive IGBT discretetes**  
High-efficiency, low-loss IGBT discretetes bundle our outstanding trench- and fieldstop technologies to reduce saturation voltages well below the levels offered by competing standard NPT IGBTs – without increasing the switching losses.




**Driver ICs**  
Our automotive-qualified gate driver ICs help simplify design and optimize performance in all FET and IGBT driving stages.




**Microcontroller**  
Our highly scalable, ASIL-D-supporting 32-bit microcontrollers dedicated to (H)EV solutions are the perfect complement to our product portfolio for energy efficient electric drivetrains.




**XENSIV™ sensors**  
Our position sensors enable close-loop feedback of the motor position for Field-Oriented Control (FOC) that supports the highest safety levels. XENSIV™ Hall switches, angular- or 3D magnetic sensors are used to control the motor commutation, increasing efficiency under varying load conditions.



**Power management IC**  
Wide portfolio of power supplies complete our semiconductor offering for auxiliary drives



**Power management IC**  
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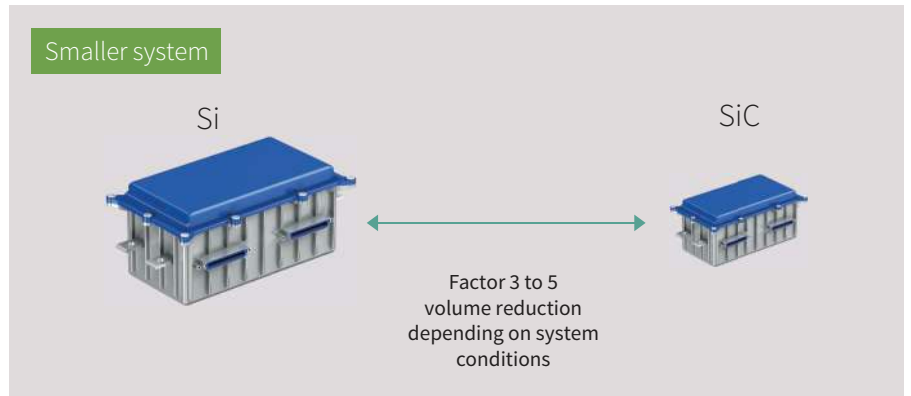
## SiC for automotive applications

Gearing up for a new generation of power electronics

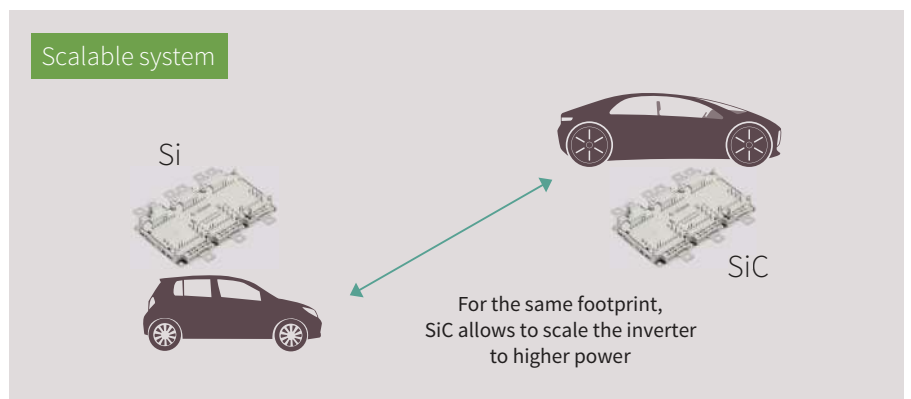
Demand for plug-in hybrid and all-electric vehicles (xEV) continues to rise. These vehicles are packed full of power electronics – most of which are currently based on silicon. However, the latest xEV designs call for advances in efficiency and power density. Silicon carbide (SiC) is emerging as the material of choice for overcoming the

performance plateau of silicon. Highlights such as low switching losses, a high temperature capability and high switching frequency make it ideal for meeting the highest xEV requirements. SiC-based solutions promise to be more efficient, compact and lighter than conventional applications.

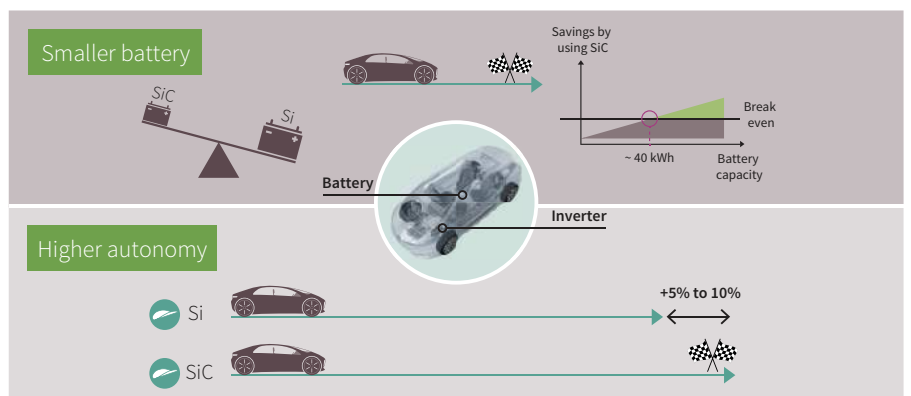
## Higher power density



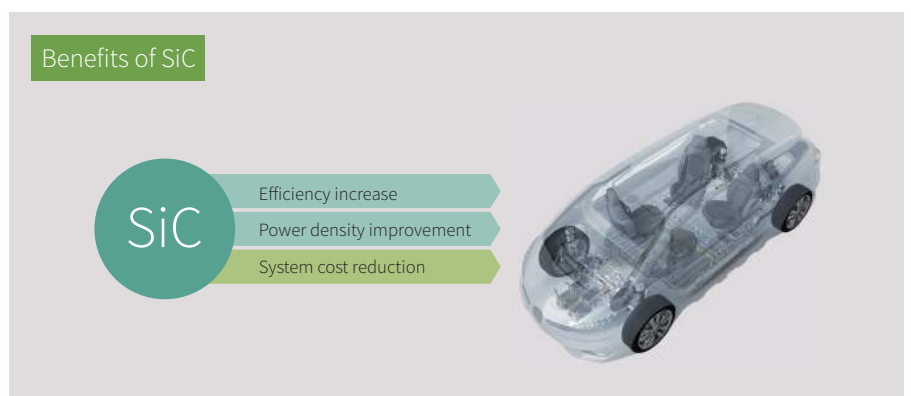
## Scalability



## Lighter, smaller battery and longer range



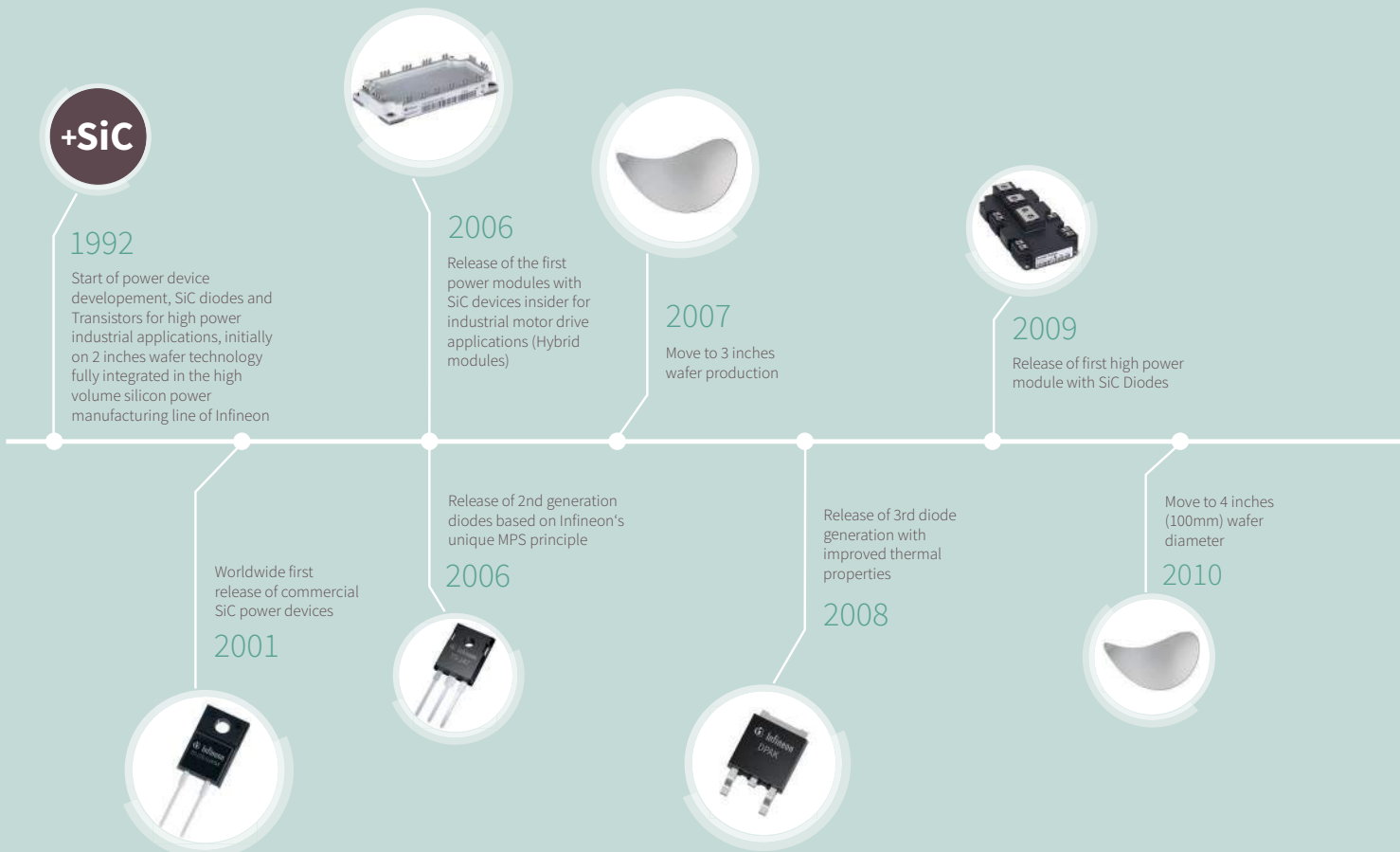
## Benefits of SiC



## Synergized expertise

As the No. 1 player in automotive power semiconductors worldwide, Infineon has developed one of the broadest technology portfolios available on the market. The company has developed expertise in silicon, SiC and gallium nitride (GaN), complemented by innovative packaging and gate driver solutions. Infineon is now leveraging over five decades of experience in both high-voltage components and automotive semiconductors to bring the benefits of SiC technology to the automotive world.

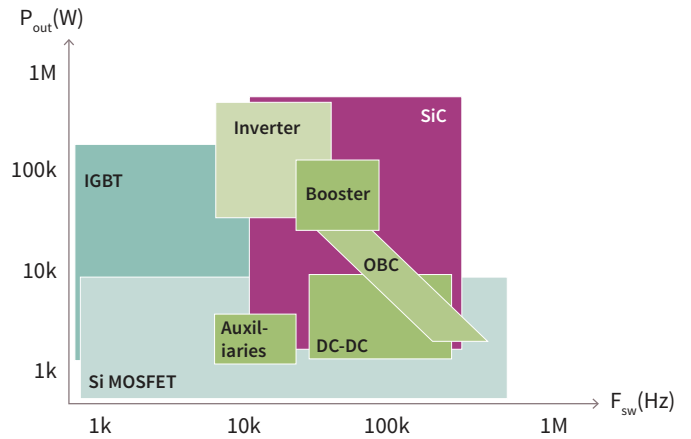
## SiC – where do we come from?



## Technology portfolio

As a technology leader for SiC power semiconductors, Infineon aims to actively drive down the cost/performance ratio of SiC and accelerate its market introduction. Building on recognized expertise in automotive systems, Infineon will support its partners in designing the next generation xEV that take full advantage of the performance potential of SiC. All this in order to create additional value for its customers.

Once Infineon is ready for an open-market approach, customers can look forward to compact and highly efficient SiC devices that offer performance and efficiency gains of up to 10 percent for a variety of driving scenarios.



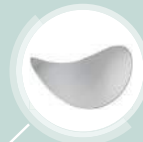
2012

Roll out of SiC portfolio for solar power string inverters



2014

Extension of the 5th generation principle towards 1200 V diodes



2015

Start of 150 mm conversion in manufacturing

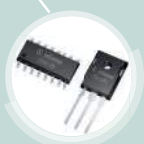
Release of 5th generation of diodes, introduction of thin wafer manufacturing for SiC

2013



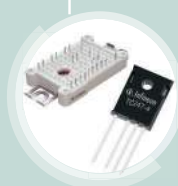
Commercial release of Infineon's ultra reliable SiC JFET switch in power modules and discrete versions

2014



Technology launch of CoolSiC™ MOSFET at the PCIM in Nuremberg



2016



# Product portfolio overview for (H)EV applications

## Automotive power modules

**HybridPACK™ 1, HybridPACK™ Light, HybridPACK™ DC6 – power module for hybrid and fully electric vehicle applications for a power range up to 100 kW**

Sales name	$I_c$ [A]	$V_{CES}$ [V]	Application	Product status	Packages
FS400R07A1E3_S7	400	705	Inverter	Released	HybridPACK™ 1
FS215R04A1E3D	215	400	Inverter	Released	HybridPACK™ 1
FS200R07A5E3_S6	200	705	Inverter	Released	HybridPACK™ Light
FS400R07A3E3	400	705	Inverter	Released	HybridPACK™ 1 DC6
FS400R07A3E3_H6 	400	705	Inverter	Released	HybridPACK™ 1 DC6 Wave
FS650R08A4P2 	650	750	Inverter	Coming Q4/2019	HybridPACK™ 1 DC6i







**HybridPACK™ 1 Pin-Fin – power module for hybrid electric vehicle applications for a power range up to 100 kW**

Sales name	$I_c$ [A]	$V_{CES}$ [V]	Application	Product status	Packages
FS400R07A1E3_H5	400	650	Inverter	Released	HybridPACK™ 1 Pin-Fin
FS200R12A1E3_H5	200	1200	Inverter	Released	HybridPACK™ 1 Pin-Fin


**HybridPACK™ 2 – power module for hybrid and fully electric vehicle applications for a power range up to 180 kW**

Sales name	$I_c$ [A]	$V_{CES}$ [V]	Application	Product status	Packages
FS900R08A2P2_B31	900	750	Inverter	Released	HybridPACK™ 2 Enhanced
FS900R08A2P2_B32	900	750	Inverter	Released	HybridPACK™ 2 Enhanced

**HybridPACK™ Drive – power module for hybrid and fully electric vehicle applications for a power range up to 175 kW**

Sales name	$I_c$ [A]	$V_{CES}$ [V]	Application	Product status	Packages
FS820R08A6P2	820	750	Inverter	Released	HybridPACK™ Drive
FS820R08A6P2B	820	750	Inverter	Released	HybridPACK™ Drive
FS820R08A6P2LB	820	750	Inverter	Released	HybridPACK™ Drive
FS660R08A6P2FB 	660	750	Inverter	Coming Q2/2019	HybridPACK™ Drive Flat
FS660R08A6P2FLB 	660	750	Inverter	Coming Q2/2019	HybridPACK™ Drive Flat
FS770R08A6P2B 	770	750	Inverter	Coming Q2/2019	HybridPACK™ Drive Wave
FS770R08A6P2LB 	770	750	Inverter	Coming Q2/2019	HybridPACK™ Drive Wave
FS950R08A6P2B 	950	750	Inverter	Coming Q2/2019	HybridPACK™ Drive Performance
FS380R12A6T4B 	380	1200	Inverter	Coming Q2/2019	HybridPACK™ Drive Performance 1200 V

**HybridPACK™ DSC – molded power module for hybrid and fully electric vehicle applications for a power range up to 75 kW**

Sales name	$I_c$ [A]	$V_{CES}$ [V]	Application	Product status	Packages
FS200R07A02E3_S6	200	700	Inverter	Released	HybridPACK™ DSC L
FF400R07A01E3_S6	400	700	Inverter	Released	HybridPACK™ DSC S1
FF450R08A03P2 	450	750	Inverter	Coming Q2/2019	HybridPACK™ DSC S2

[www.infineon.com/hybridpack](http://www.infineon.com/hybridpack)

**Automotive EasyPACK™ modules – power modules for auxiliaries and charger applications up to 10 kW**

Sales name	$I_c$ [A]	$V_{CES}$ [V]	Application	Product status	Packages
FS75R07W2E3_B11A	75	650	Inverter	Released	Automotive EasyPACK™ 2B
FS50R07W1E3_B11A	50	650	Inverter	Released	Automotive EasyPACK™ 1B
F4-50R07W1H3_B11A	50	650	DC-DC converter	Released	Automotive EasyPACK™ 1B
F4-75R07W1H3_B11A	75	650	DC-DC converter	Released	Automotive EasyPACK™ 1B

















[www.infineon.com/autoeasy](http://www.infineon.com/autoeasy)

**Evaluation kits**

Board name	SP nummer	Description
HybridKIT™ 1+	SP000806996	Evaluation kit for applications with HybridPACK™ 1 FS400R07A1E3
Easy kit DC-DC	SP001007734	Evaluation kit for applications with EasyPACK™ 1B F4-50R07W1H3_B11A
HybridKIT™ Drive	SP001464622	Inverter evaluation kit with HybridPACK™ Drive FS820R08A6P2B
HybridKIT™ Drive sense	SP001464626	Inverter evaluation kit with HybridPACK™ Drive FS820R08A6P2LB (long AC tabs) and LEM current sensor
HybridKIT™ DSC	Coming Q2/2019	Inverter evaluation kit with HybridPACK™ DSC S FF400R07A01E3_S6
HybridKIT™ DSC S1	SP001683524	Inverter evaluation kit with HybridPACK™ DSC S1 FF400R07A01E3_S6
HybridKIT™ DSC S2	Coming Q3/2019	Inverter evaluation kit with HybridPACK™ DSC S2 FF450R08A3P2

[www.infineon.com/evaluation-boards](http://www.infineon.com/evaluation-boards)

# Discrete IGBTs

Sales name	$I_c$ [A] <sup>1)</sup>	$V_{CES}$ [V] <sup>2)</sup>	Incl. diode	Application	Product status	Packages
AIKB20N60CT	20	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-263-3-2
AIKP20N60CT	20	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-220-3-1
AIKQ100N60CT	100	600	Yes	Main Inverter, Motor drives, AirCon/HVAC	Released	TO-247-3-46
AIKQ120N60CT	120	600	Yes	Main Inverter, Motor drives, AirCon/HVAC	Released	TO-247-3-46
AIKW20N60CT	20	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-247-3-41
AIKW30N60CT	30	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-247-3-41
AIKW50N60CT	50	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-247-3-41
AIKW75N60CT	75	600	Yes	Main inverter, Motor drives, AirCon/HVAC	Released	TO-247-3-41
AIGB15N65F5 	15	650	No	DC-DC converter, On-board charger	Released	TO-263-3-2
AIGB15N65H5 	151	650	No	DC-DC converter, On-board charger	Released	TO-263-3-2
AIGB30N65F5 	30	650	No	DC-DC converter, On-board charger	Released	TO-263-3-2
AIGB30N65H5 	30	650	No	DC-DC converter, On-board charger	Released	TO-263-3-2
AIGB40N65F5 	40	650	No	DC-DC converter, On-board charger	Released	TO-263-3-2
AIGB40N65H5 	40	650	No	DC-DC converter, On-board charger	Released	TO-263-3-2
AIGB50N65F5 	50	650	No	DC-DC converter, On-board charger	Released	TO-263-3-2
AIGB50N65H5 	50	650	No	DC-DC converter, On-board charger	Released	TO-263-3-2
AIKB15N65DF5 	15	650	Yes	DC-DC converter, On-board charger	Released	TO-263-3-2
AIKB15N65DH5 	15	650	Yes	DC-DC converter, On-board charger	Released	TO-263-3-2
AIKB30N65DF5 	30	650	Yes	DC-DC converter, On-board charger	Released	TO-263-3-2
AIKB30N65DH5 	30	650	Yes	DC-DC converter, On-board charger	Released	TO-263-3-2
AIKB40N65DF5 	40	650	Yes	DC-DC converter, On-board charger	Released	TO-263-3-2
AIKB40N65DH5 	40	650	Yes	DC-DC converter, On-board charger	Released	TO-263-3-2
AIKB50N65DF5 	50	650	Yes	DC-DC converter, On-board charger	Released	TO-263-3-2
AIKB50N65DH5 	50	650	Yes	DC-DC converter, On-board charger	Released	TO-263-3-2
AIGW40N65F5	40	650	No	DC-DC converter, On-board charger	Released	TO-247-3-41
AIGW40N65H5	40	650	No	DC-DC converter, On-board charger	Released	TO-247-3-41
AIGW50N65F5	50	650	No	DC-DC converter, On-board charger	Released	TO-247-3-41
AIGW50N65H5	50	650	No	DC-DC converter, On-board charger	Released	TO-247-3-41
AIKW40N65DF5	40	650	Yes	DC-DC converter, On-board charger	Released	TO-247-3-41
AIKW40N65DH5	40	650	Yes	DC-DC converter, On-board charger	Released	TO-247-3-41
AIKW50N65DF5	50	650	Yes	DC-DC converter, On-board charger	Released	TO-247-3-41
AUIRG4BC30U-S	12	600	No	PTC heater	Released	TO-263-3-2
AUIRG4PC40S-E	31	600	No	PTC heater	Released	TO-247AD
AUIRG4PH50S	33	1200	No	PTC heater	Released	TO-247AC



Sales name	$I_C$ [A] <sup>1)</sup>	$V_{CES}$ [V] <sup>2)</sup>	Incl. diode	Application	Product status	Packages
AUIRGB4062D1	39	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-220AB
AUIRGP35B60PD	34	600	Yes	DC-DC converter, On-board charger	Released	TO-247AC
AUIRGP35B60PD-E	34	600	Yes	DC-DC converter, On-board charger	Released	TO-247AD
AUIRGP4062D	24	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-247AC
AUIRGP4062D-E	24	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-247AD
AUIRGP4063D	48	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-247AC
AUIRGP4066D1	90	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO-247AC
AUIRGP50B60PD1	45	600	Yes	DC-DC converter, On-board charger	Released	TO-247AC
AUIRGP65G40D0	41	600	Yes	DC-DC converter, On-board charger	Released	TO-247AC
AUIRGF65G40D0	41	600	Yes	DC-DC converter, On-board charger	Released	TO-247AD
AUIRGP66524D0	40	600	Yes	DC-DC converter, On-board charger	Released	TO-247AC
AUIRGF66524D0	40	600	Yes	DC-DC converter, On-board charger	Released	TO-247AD
AUIRGPS4070D0	120	600	Yes	Main inverter, Motor drives, AirCon/HVAC	Released	Super-274
AUIRGR4045D	6	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	DPAK (TO-252)
AUIRGS30B60K	50	600	No	Motor drives, AirCon/HVAC, PTC heater	Released	D2PAK (TO-263)
AUIRGS4062D1	39	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	D2PAK (TO-263)
AUIRGL30B60K	50	600	No	Motor drives, AirCon/HVAC, PTC heater	Released	TO262-3-901
AUIRGL4062D1	39	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	TO262-3-901
AUIRGU4045D	6	600	Yes	Motor drives, AirCon/HVAC, PTC heater	Released	IPAK (TO-251)

1)  $I_C$  = Nominal current

2)  $V_{CES}$  = Collector to emitter saturation voltage

[www.infineon.com/automotive-igbt-discretes](http://www.infineon.com/automotive-igbt-discretes)

# CoolMOS™ superjunction power MOSFET

## 650 V CoolMOS™ CFDA

$R_{DS(ON)}$ [mΩ]	TO-252 DPAK	TO-263 D <sup>2</sup> PAK	TO-220	TO-247
660	IPD65R660CFDA	IPB65R660CFDA		
420	IPD65R420CFDA			
310		IPB65R310CFDA	IPP65R310CFDA	
190		IPB65R190CFDA	IPP65R190CFDA	IPW65R190CFDA
150		IPB65R150CFDA	IPP65R150CFDA	IPW65R150CFDA
110		IPB65R110CFDA	IPP65R110CFDA	IPW65R110CFDA
80				IPW65R080CFDA
48				IPW65R048CFDA

## 600 V CoolMOS™ CPA

$R_{DS(ON)}$ [mΩ]	TO-262 I <sup>2</sup> PAK	TO-263 D <sup>2</sup> PAK	TO-220	TO-247
299		IPB60R299CPA		
199		IPB60R199CPA		
99	IPD60R099CPA	IPB60R099CPA	IPP60R099CPA	IPW60R099CPA
75				IPW60R075CPA
45				IPW60R045CPA

## 800 V CoolMOS™ C3A

$R_{DS(ON)}$ [mΩ]	TO-252 DPAK	TO-263 D <sup>2</sup> PAK	TO-247
2700	IPD80R2k7C3A		
290		IPB80R290C3A	IPW80R290C3A

[www.infineon.com/coolmos](http://www.infineon.com/coolmos)

[www.infineon.com/coolmos-automotive](http://www.infineon.com/coolmos-automotive)

[www.infineon.com/cfda](http://www.infineon.com/cfda)


# Automotive gate driver ICs

Suitable for our power products: EiceDRIVER™ – Gate drivers providing galvanic isolation and bidirectional signal transmission with a high ambient temperature capability (supporting IGBT and SiC technologies)

Sales name	$I_{\text{Output}}$ [A]	Maximum voltage class [V] (supported IGBT technologies)	Packages	Product status
1ED020I12FTA	2	1200	DSO-20	Released
2ED020I12FA	2	1200	DSO-36	Released
1ED020I12FA2	2	1200	DSO-20	Released
1EDI2002AS	2	1200	DSO-36	Released
1EBN1001AE	15	1200	DSO-14	Released
1EDI2010AS	2	1200	DSO-36	Released
1EDI2004AS	2	1200	DSO-36	Released

[www.infineon.com/automotive-eicedriver](http://www.infineon.com/automotive-eicedriver)

Infineon's comprehensive portfolio of automotive-qualified gate driver ICs helps simplify design and optimize performance in all Fets and IGBTs driving stages.

Sales name	$I_{\text{Output}}$ [mA]	Maximum voltage class [V]	Packages	Product status
AUIRS2336S	200	600	SOIC-28W	Released
AUIRS1170S	3000	600	PSOP-8L	Released
AUIRS2113S	2500	600	SOIC-16	Released
AUIRS2181S	1900	600	SOIC-8	Released
AUIRS21811S	1900	600	SOIC-8	Released
AUIRS21814S	1900	600	SOIC-8	Released
AUIRS2191S	3500	600	SOIC-8	Released
AUIRS2301S	200	600	SOIC-8	Released
AUIRB24427S	6000	600	SOIC-8	Released
AUIRS2117S	290	600	SOIC-8	Released
AUIRS2118S	290	600	SOIC-8	Released
AUIRS2123S	500	600	SOIC-8	Released
AUIRS2124S	500	600	SOIC-8	Released
AUIRS2127S	290	600	SOIC-8	Released
AUIRS21271S	290	600	SOIC-8	Released
AUIR08152S	10000	40	SOIC-8	Released
AUIR2085STR	1000	600	SOIC-8N	Released
AUIR2114SS 	3000	700	SSOP-24	In development (samples available)

[www.infineon.com/gate-driver-ics](http://www.infineon.com/gate-driver-ics)

## CoolSiC™ automotive Schottky diode

Sales name	$I_F$ [A]	$V_{DC}$ [V]	Application	Product status	Packages
AIDW10S65C5	10	650	On-board charger, Auxiliaries	Released	TO247-3-41
AIDW12S65C5	12	650	On-board charger, Auxiliaries	Released	TO247-3-41
AIDW16S65C5	16	650	On-board charger, Auxiliaries	Released	TO247-3-41
AIDW20S65C5	20	650	On-board charger, Auxiliaries	Released	TO247-3-41
AIDW30S65C5	30	650	On-board charger, Auxiliaries	Released	TO247-3-41
AIDW40S65C5	40	650	On-board charger, Auxiliaries	Released	TO247-3-41

[www.infineon.com/coolpic-schottky-diode](http://www.infineon.com/coolpic-schottky-diode)

## Battery management sensing IC

Sales name	# channels	Function	Balancing current [mA]	Temperature sensors	Communication interface
TLE9012AQU	12	Sensing and balancing	150	5	isoUART
TLE9015QU	-	Transceiver	-	-	UART/isoUART

## High-speed CAN transceiver with Flexible Data-rate up to 5 Mbit/s

Sales name	Transmission rate (max)	Low-power mode $I_q$ [ $\mu$ A] (max)	Bus wake-up capability	Wake-up inputs	Number of channels	CAN FD	Package
High-speed CAN ISO 11898-5							
TLE9251VSJ	5 Mbit/s	< 15 $\mu$ A @ 5 V stand-by	•		1	•	DSO-8
TLE9251VLE	5 Mbit/s	< 15 $\mu$ A @ 5 V stand-by	•		1	•	TSON-8
TLE9251SJ	5 Mbit/s	< 15 $\mu$ A @ 5 V stand-by	•		1	•	DSO-8
TLE9251LE	5 Mbit/s	< 15 $\mu$ A @ 5 V stand-by	•		1	•	TSON-8
TLE9252VSK	5 Mbit/s	< 26 sleep mode	•	•	1	•	DSO-14
TLE9252VLC	5 Mbit/s	< 26 sleep mode	•	•	1	•	TSON-14

## Automotive power supplies

OPTIREG™ automotive PMIC: ISO26262-compliant, multi-rail power supply with microcontroller-, communication-, and sensor- supply rails and monitoring/supervisory functions.

Sales name	Microcontroller main voltage [V]	Product status	Packages
TLF35584QVWS1	5.0	Released	VQFP-48
TLF35584QVWS2	3.3	Released	VQFP-48
TLF35584QKVS1	5.0	Released	LQFP-64
TLF35584QKVS2	3.3	Released	LQFP-64

[www.infineon.com/optireg](http://www.infineon.com/optireg)

# Automotive microcontrollers

Product type	Cores/lockstep	Max. clock frequency [MHz]	Program memory [KByte]	SRAM (incl. cache) [KByte]	CAN/CAN FD nodes	Ethernet availability	External bus interface <sup>2)</sup>	Communication interfaces <sup>2)</sup>	HSM <sup>3)</sup>	Temperature ranges <sup>4)</sup>	Packages	Additional features/remarks <sup>5)</sup>
<b>AURIX™ TC3xx family</b>												
TC399XP	6/4	300	16000	2816	12	1 Gbit/s	EBU, eMMC, 2x HSSL	6x SPI, 2x FlexRay, 12x ASCLIN, 25x SENT, 4x PSi5, 2x I <sup>2</sup> C, 4x MSC	EVITA full	K, L	LFBGA-516	5/3.3 V EVR, 8-bit SCR
TC397XX	6/4	300	16000	6912	12	1 Gbit/s	eMMC, 2x HSSL	6x SPI, 2x FlexRay, 12x ASCLIN, 25x SENT, 4x PSi5, 2x I <sup>2</sup> C, 4x MSC	EVITA full	K, L	LFBGA-292	5/3.3 V EVR, 8-bit SCR
TC397XP	6/4	300	16000	2816	12	1 Gbit/s	eMMC, 2x HSSL	6x SPI, 2x FlexRay, 12x ASCLIN, 25x SENT, 4x PSi5, 2x I <sup>2</sup> C, 4x MSC	EVITA full	K, L	LFBGA-292	5/3.3 V EVR, 8-bit SCR
TC3E7QF	4/2	300	12000	1696	12	1 Gbit/s	HSSL	5x SPI, 2x FlexRay, 24x ASCLIN, 20x SENT, 4x PSi5, 2x I <sup>2</sup> C, 2x MSC	EVITA full	K, L	LFBGA-292	5/3.3 V EVR, 8-bit SCR
TC389QP	4/2	300	16000	1568	12	1 Gbit/s	HSSL	5x SPI, 2x FlexRay, 24x ASCLIN, 25x SENT, 4x PSi5, 2x I <sup>2</sup> C, 3x MSC	EVITA full	K, L	LFBGA-516	5/3.3 V EVR, 8-bit SCR
TC387QP	4/2	300	10000	1568	12	1 Gbit/s	HSSL	5x SPI, 2x FlexRay, 24x ASCLIN, 20x SENT, 4x PSi5, 2x I <sup>2</sup> C, 2x MSC	EVITA full	K, L	LFBGA-292	5/3.3 V EVR, 8-bit SCR
TC377TP	3/2	300	6000	1136	8	1 Gbit/s	HSSL	5x SPI, 1x FlexRay, 12x ASCLIN, 15x SENT, 2x PSi5, 1x I <sup>2</sup> C, 2x MSC	EVITA full	K, L	LFBGA-292	5/3.3 V EVR, 8-bit SCR
TC375TP	3/2	300	6000	1136	8	100 Mbit/s	HSSL	5x SPI, 1x FlexRay, 12x ASCLIN, 15x SENT, 2x PSi5, 1x I <sup>2</sup> C, 2x MSC	EVITA full	K, L	LQFP-176	5/3.3 V EVR, 8-bit SCR
TC367DP	2/2	300	4000	672	8	1 Gbit/s	HSSL	4x SPI, 1x FlexRay, 12x ASCLIN, 10x SENT, 2x PSi5, 1x I <sup>2</sup> C, 1x MSC	EVITA full	K, L	LFBGA-292	5/3.3 V EVR, 8-bit SCR
TC365DP	2/2	300	4000	672	8	100 Mbit/s	HSSL	4x SPI, 1x FlexRay, 12x ASCLIN, 10x SENT, 2x PSi5, 1x I <sup>2</sup> C, 1x MSC	EVITA full	K, L	LQFP-176	5/3.3 V EVR, 8-bit SCR
TC364DP	2/2	300	4000	672	8	100 Mbit/s	HSSL	4x SPI, 1x FlexRay, 12x ASCLIN, 10x SENT, 2x PSi5, 1x I <sup>2</sup> C, 1x MSC	EVITA full	K, L	TQFP-144 / LQFP-144	5/3.3 V EVR, 8-bit SCR
TC337LP	1/1	300	2000	248	8	No	No	4x SPI, 1x FlexRay, 12x ASCLIN, 6x SENT	EVITA full	K, L	LFBGA-292	5/3.3 V EVR, 8-bit SCR
TC334LP	1/1	300	2000	248	8	No	No	4x SPI, 1x FlexRay, 12x ASCLIN, 6x SENT	EVITA full	K, L	TQFP-144	5/3.3 V EVR, 8-bit SCR
TC333LP	1/1	300	2000	248	6	No	No	4x SPI, 1x FlexRay, 5x ASCLIN, 6x SENT	EVITA full	K, L	TQFP-100	5/3.3 V EVR, 8-bit SCR

1) EBU = External Bus Unit, eMMC = external MultiMediaCard, HSSL = High-Speed Serial Link

2) SPI = Serial Peripheral Interface, ASCLIN = Asynchronous/Synchronous Serial Channel Local Interconnect Network, SENT = Single Edge Nibble Transmission, PSi5 = Peripheral Sensor Interface 5, I<sup>2</sup>C = Inter-Integrated Circuit, MSC = Micro Second Channel

3) HSM = Hardware Security Module

4) Ambient temperature range: K = -40 ... 125°C, L = -40 ... 150°C

5) EVR = Embedded Voltage Regulator, 8-bit SCR = Standby Controller for low-power modes

# Automotive microcontrollers

Product type	Cores/lockstep	Max. clock frequency [MHz]	Program memory [KByte]	SRAM (incl. cache) [KByte]	CAN/CAN FD nodes	Ethernet availability	External bus interface <sup>2)</sup>	Communication interfaces <sup>2)</sup>	HSM <sup>3)</sup>	Temperature ranges <sup>4)</sup>	Packages	Additional features/remarks <sup>5)</sup>
<b>AURIX™ TC2xx family</b>												
TC299TP	3/1	300	8000	728	6	100 Mbit/s	EBU, HSSL	6x SPI, 2x FlexRay, 4x ASCLIN, 15x SENT, 5x PSi5, 2x I <sup>2</sup> C, 3x MSC	EVITA medium	K, L	LFBGA-516	5/3.3 V EVR
TC298TP	3/1	300	8000	728	6	100 Mbit/s	HSSL	6x SPI, 2x FlexRay, 4x ASCLIN, 15x SENT, 5x PSi5, 2x I <sup>2</sup> C, 3x MSC	EVITA medium	K, L	LBGA-416	5/3.3 V EVR
TC297TP	3/1	300	8000	728	6	100 Mbit/s	HSSL	6x SPI, 2x FlexRay, 4x ASCLIN, 15x SENT, 5x PSi5, 2x I <sup>2</sup> C, 3x MSC	EVITA medium	K, L	LFBGA-292	5/3.3 V EVR
TC277TP	3/2	200	4000	472	4	100 Mbit/s	HSSL	4x SPI, 1x FlexRay, 4x ASCLIN, 10x SENT, 3x PSi5, 1x I <sup>2</sup> C, 2x MSC	EVITA medium	K, L	LFBGA-292	5/3.3 V EVR
TC275TP	3/2	200	4000	472	4	100 Mbit/s	HSSL	4x SPI, 1x FlexRay, 4x ASCLIN, 10x SENT, 3x PSi5, 1x I <sup>2</sup> C, 2x MSC	EVITA medium	K, L	LQFP-176	5/3.3 V EVR
TC265D	2/1	200	2500	240	5	100 Mbit/s	HSSL	4x SPI, 1x FlexRay, 4x ASCLIN, 6x SENT, 2x PSi5, 1x I <sup>2</sup> C, 2x MSC	No	K, L	LQFP-176	5/3.3 V EVR
TC264D	2/1	200	2500	240	5	100 Mbit/s	HSSL	4x SPI, 1x FlexRay, 4x ASCLIN, 6x SENT, 2x PSi5, 1x I <sup>2</sup> C, 2x MSC	No	K, L	LQFP-144	5/3.3 V EVR
TC234LP	1/1	200	2000	192	6	No	No	4x SPI, 1x FlexRay, 2x ASCLIN, 4x SENT	EVITA medium	K, L	TQFP-144	3.3 V EVR
TC233LP	1/1	200	2000	192	6	No	No	4x SPI, 1x FlexRay, 2x ASCLIN, 4x SENT	EVITA medium	K, L	TQFP-100	3.3 V EVR
TC224L	1/1	133	1000	96	3	No	No	4x SPI, 2x ASCLIN, 4x SENT	No	K, L	TQFP-144	3.3 V EVR
TC223L	1/1	133	1000	96	3	No	No	4x SPI, 2x ASCLIN, 4x SENT	No	K, L	TQFP-100	3.3 V EVR
TC222L	1/1	133	1000	96	3	No	No	4x SPI, 2x ASCLIN, 4x SENT	No	K, L	TQFP-80	3.3 V EVR

- 1) EBU = External Bus Unit, eMMC = external MultiMediaCard, HSSL = High-Speed Serial Link
- 2) SPI = Serial Peripheral Interface, ASCLIN = Asynchronous/Synchronous Serial Channel Local Interconnect Network, SENT = Single Edge Nibble Transmission, PSi5 = Peripheral Sensor Interface 5, I<sup>2</sup>C = Inter-Integrated Circuit, MSC = Micro Second Channel
- 3) HSM = Hardware Security Module
- 4) Ambient temperature range: K = -40 ... 125°C, L = -40 ... 150°C
- 5) EVR = Embedded Voltage Regulator

# XENSIV™ – automotive position sensors

Angle sensors suitable for motor position applications within the main drive and auxiliary loads

Product	Technology	Number of dies	Angle output	Accuracy (full temperature range and lifetime)	Applications	Product status	Package
TLE5012B(D)	GMR	Single and dual die	SSC (SPI); second interface PWM/IIF/SPC/HSM	1.0°	Main drive, auxiliary drives	Released	TDSO-16
TLE5014x16(D)	GMR	Single and dual die	SPC, SENT, PWM, SPI	1.0°	Main drive, auxiliary drives	Released	TDSO-16
TLE5009A16(D)	GMR	Single and dual die	Analog sin/cos	1.0°	Main drive, auxiliary drives	Released	TDSO-16
TLE5109A16(D)	AMR	Single and dual die	Analog sin/cos	0.5°	Main drive, auxiliary drives	Released	TDSO-16
TLE5309D	AMR + GMR	Dual die	Analog sin/cos	AMR 0.5°, GMR 1.0°	Main drive, auxiliary drives	Released	TDSO-16
TLE5501	TMR	Singel die	Analog sin/cos	1.0°	Main drive, auxiliary drives	Released	DSO-8

### Hall switches suitable for motor position applications within the main drive and auxiliary loads

Product	Type	Operating point B <sub>OP</sub>	Release point B <sub>RP</sub>	Application	Product status	Package
TLE4961-1M/-2M/-3M/-4M/-5M/-6M	Latch	2.0/5.0/7.5/10.0/15.0	-2.0/-5.0/-7.5/-10.0/-15.0	Auxiliary drives	Released	SOT23/SSO-3-2
TLE4964-1M/-2M/-3M/-4M/-5M/-6M	Switch	18.0/28.0/12.5/10.0/7.5/3.5	12.5/22.5/9.5/8.5/5.0/2.5	Auxiliary drives	Released	SOT23/SSO-3-2
TLE4968-1M/L	Bipolar	1.0	-1.0	Auxiliary drives	Released	SOT23/SSO-3-2

### 3D sensors suitable for motor position applications within the main drive and auxiliary loads

Product	Technology	Accuracy	Angle output	Application	Product status	Package
TLE493D-A2B6	Hall	1° (x/y) 4.5° (xy/z)	I <sup>2</sup> C (x/y vectors) (xy/z vectors)	Main drive, Auxiliary loads	Released	TSOP-6
TLE493D-W2B6	Hall	1° (x/y) 4.5° (xy/z)	I <sup>2</sup> C (x/y vectors) (xy/z vectors)	Main drive, Auxiliary loads	Released	TSOP-6

### LinHall for current sensing

Product	Technology	Interface	Application	Product status	Package
TLE4997	Hall	Analog	Closed loop current sensor Modules for current measurement in DC-DC, AUX-inverter and motor torque control	Released	SSO-3-10, TDSO-8
TLE4998C	Hall	SPC		Released	SSO-3-10, SSO-4-1, TDSO-8
TLE4998P	Hall	PWM		Released	SSO-3-10, SSO-4-1, TDSO-8
TLE4998S	Hall	SENT		Released	SSO-3-10, SSO-4-1, TDSO-8

### Current sensor TLI4971

Sales name	Application	Current range [A <sub>RMS</sub> ]	Bandwidth [kHz]	Sensitive error [%]	V <sub>DD</sub> [V]	UL certification	Product status	Package
TLI4971-A050T5	Drives for industry market	±70	120	±2	3.3	No	In development	TISON-8
TLI4971-A050T5U	Drives for industry market	±70	120	±2	3.3	UL 1577	In development	TISON-8

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