



# Electrifying commercial, construction and agricultural vehicles

March 2021



# Agenda

---

- 1 Market trends in CAV
- 2 Challenges and Infineon solutions
- 3 Infineon components for electrification in CAV
- 4 Focus product tables
- 5 Summary

# Agenda

---

- 1 Market trends in CAV
- 2 Challenges and Infineon solutions
- 3 Infineon components for electrification in CAV
- 4 Focus product tables
- 5 Summary

# Infinion focuses on the Commercial, Construction & Agriculture Vehicle (CAV) market and Megatrends



Infinion focuses on CAV and enables clean, safe and smart vehicles

**Commercial vehicles**



**Construction vehicles**



**Agricultural vehicles**



Semiconductors are essential to realize the megatrends in CAV

**Electrification**



**Safety & ADAS**



**Connectivity & Security**



# Megatrends of the CAV market are similar to those of passenger cars

## Electrification



- › Enhanced energy recuperation
- › Electrification of side loads and powertrain
- › Electrification of powertrain

- › Powerful energy storage
- › Efficient drive train

## Safety & ADAS



- › Enhanced emergency braking
- › Enhanced highway pilot
- › V2V – platooning
- › Remote control maneuver

- › Sensor fusion
- › System redundancy

## Connectivity & Security



- › Networked information, navigation information
- › Vehicle to infrastructure connectivity

- › Increased data output & secure data- and energy supply

## Challenges

IT-security

Functional safety

Energy recuperation

Diagnosis

Energy distribution

Increasing E/E complexity

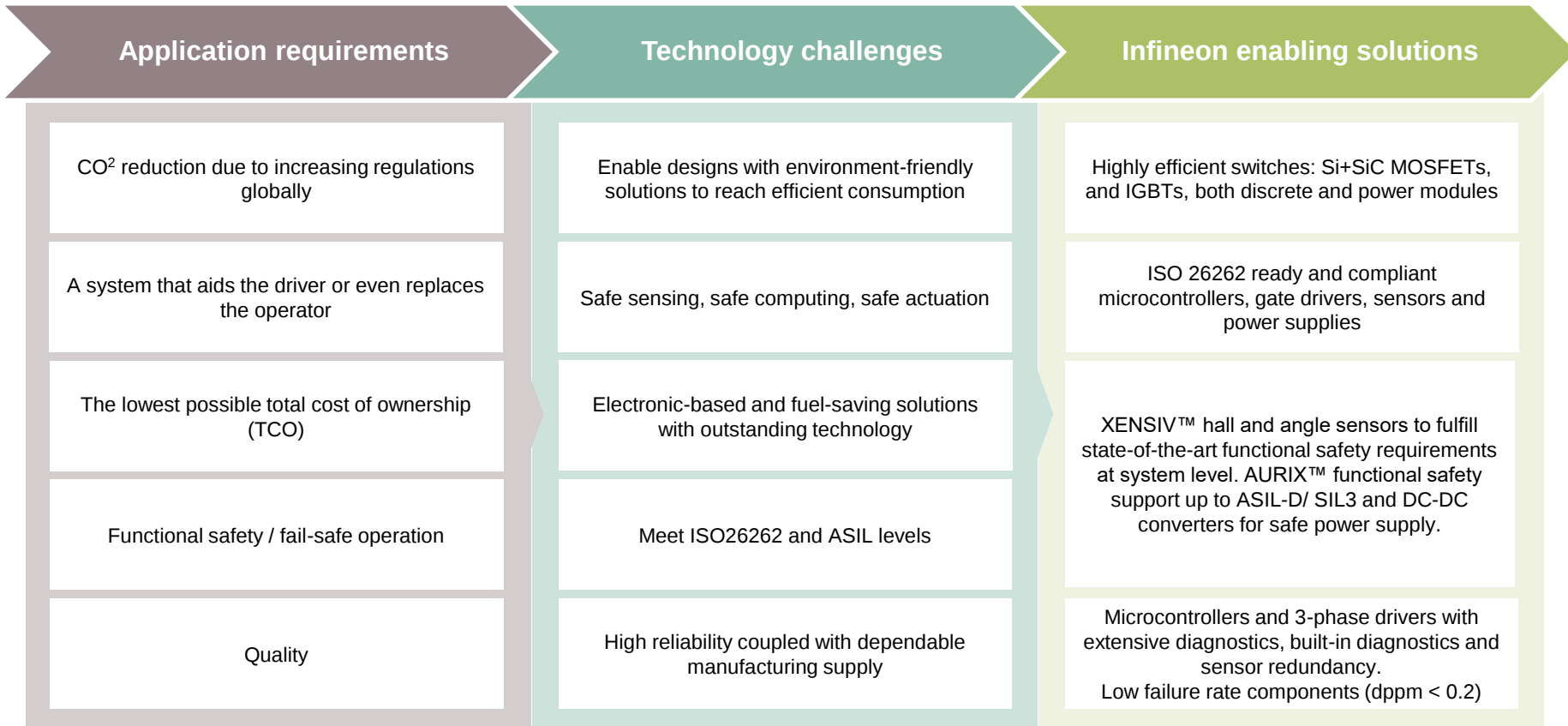
Fail operational

# Agenda

---

- 1 Market trends in CAV
- 2 Challenges and Infineon solutions
- 3 Infineon components for electrification in CAV
- 4 Focus product tables
- 5 Summary

# Application requirements and technology challenges

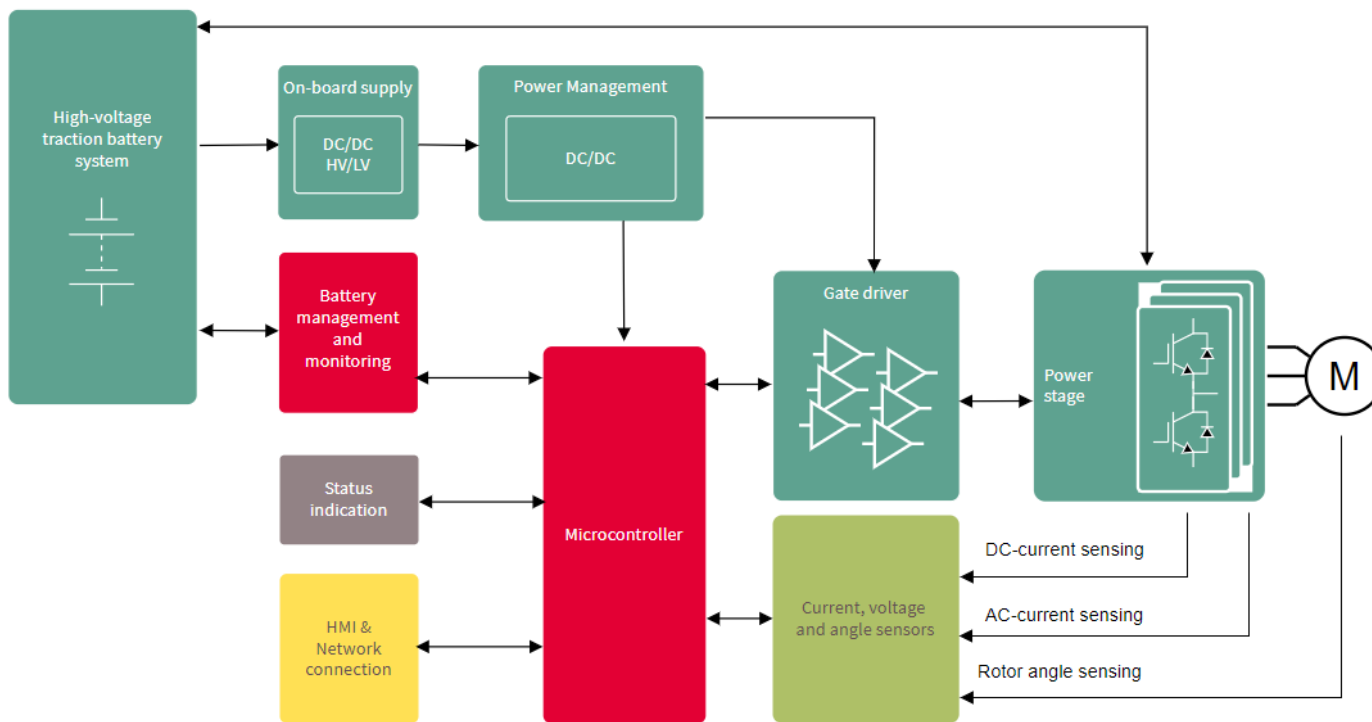


# Agenda

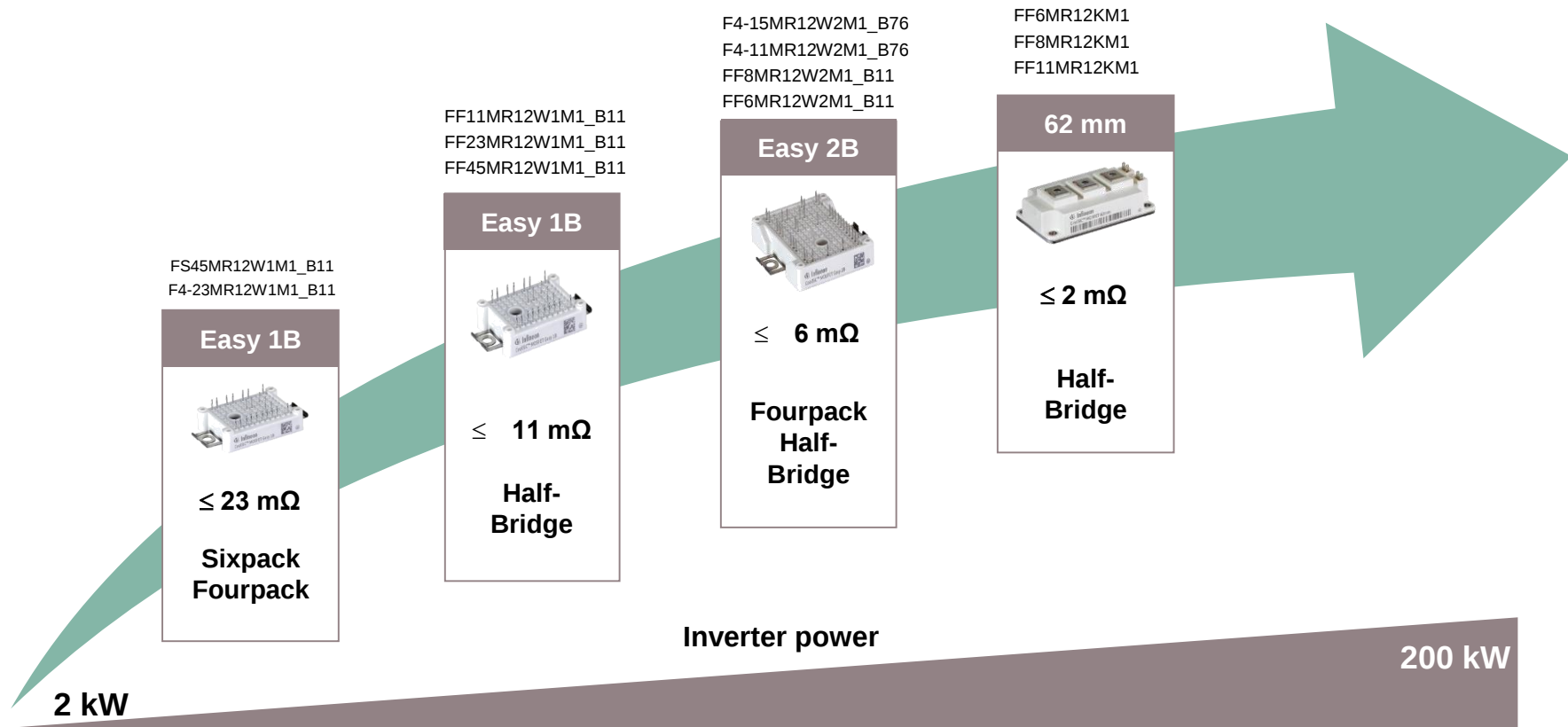
---

- 1 Market trends in CAV
- 2 Challenges and Infineon solutions
- 3 Infineon components for electrification in CAV
- 4 Focus product tables
- 5 Summary

# Typical block diagram in CAV



# CoolSiC™ MOSFETs



# Evaluation boards for CoolSiC™ Easy modules

## CoolSiC™ MOSFET motor drives evaluation board for 7.5 kW



204 mm x 259 mm

### Features

- › Complete evaluation board including a 3-phase SiC power module for motor drive applications (FS45MR12W1M1\_B11)
- › Equipped with all assembly groups for sensorless field oriented control (FOC)
- › Overtemperature and overcurrent protection as well as short circuit protection

### Benefits

- › MADK is optimized to GPD / Servo drives with very high  $f_{sw}$
- › Including the Easy 1B with CoolSiC™ MOSFET in sixpack configuration
- › Equipped with all assembly groups for sensorless field oriented control (FOC)
- › Overtemperature and overcurrent protection as well as short circuit protection

### Eval-M5-E1B1245N-SiC



[click here for more information](#)

# Evaluation boards for CoolSiC™ Easy modules

## Evaluation board for CoolSiC™ Easy1B half-bridge modules



133 mm x 175 mm

## Features

- › Bi-directional buck-boost converter combination with the EiceDRIVER™ 1EDI60IH12AH driver.
- › The configuration of the board allows to do double-pulse characterization and functional testing using electrical loads at the input or output stage

## Benefits

- › Double pulse characterization
- › Functional testing of the buck-boost operation using electrical loads at the input or output stage

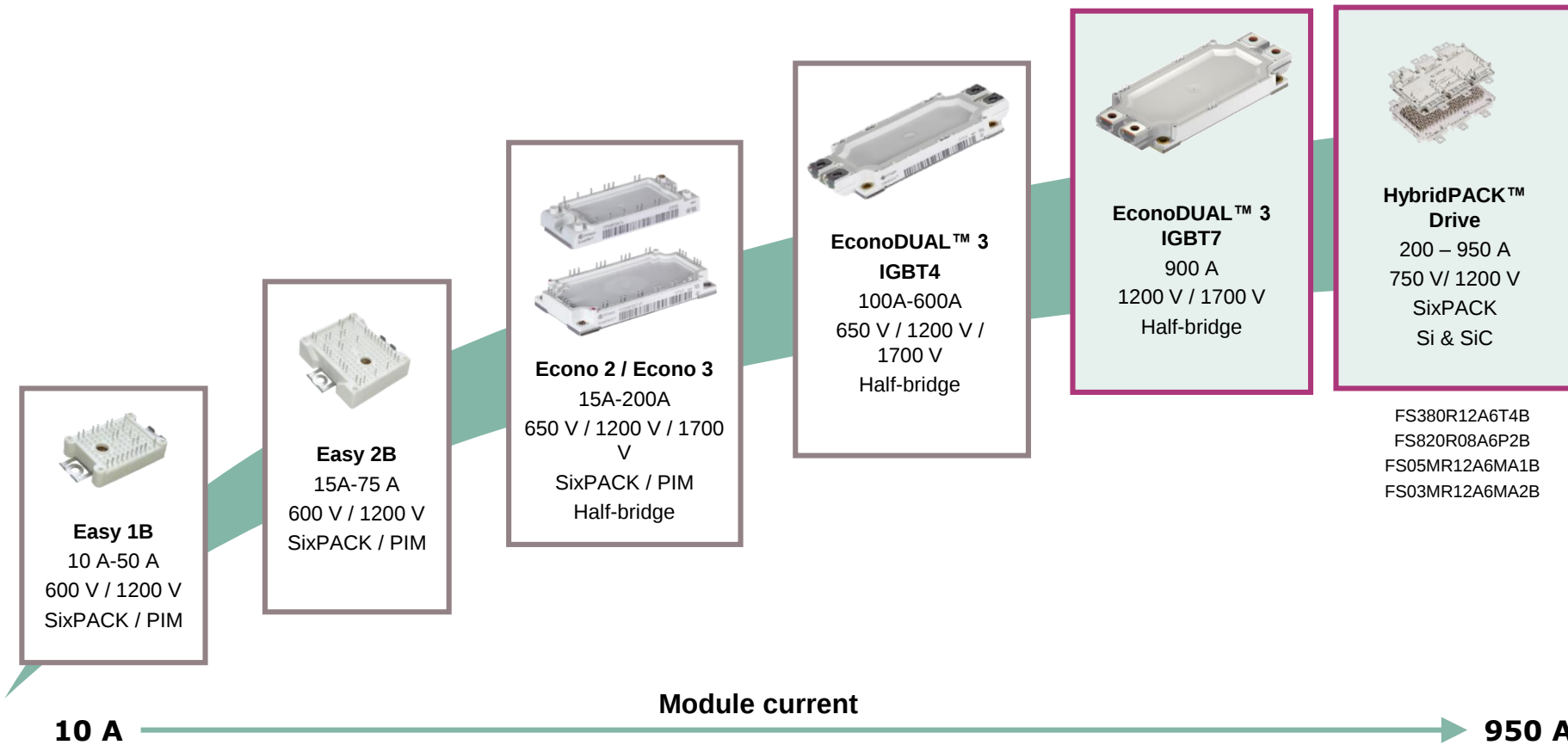
## EVAL-PS-E1BF12-SiC



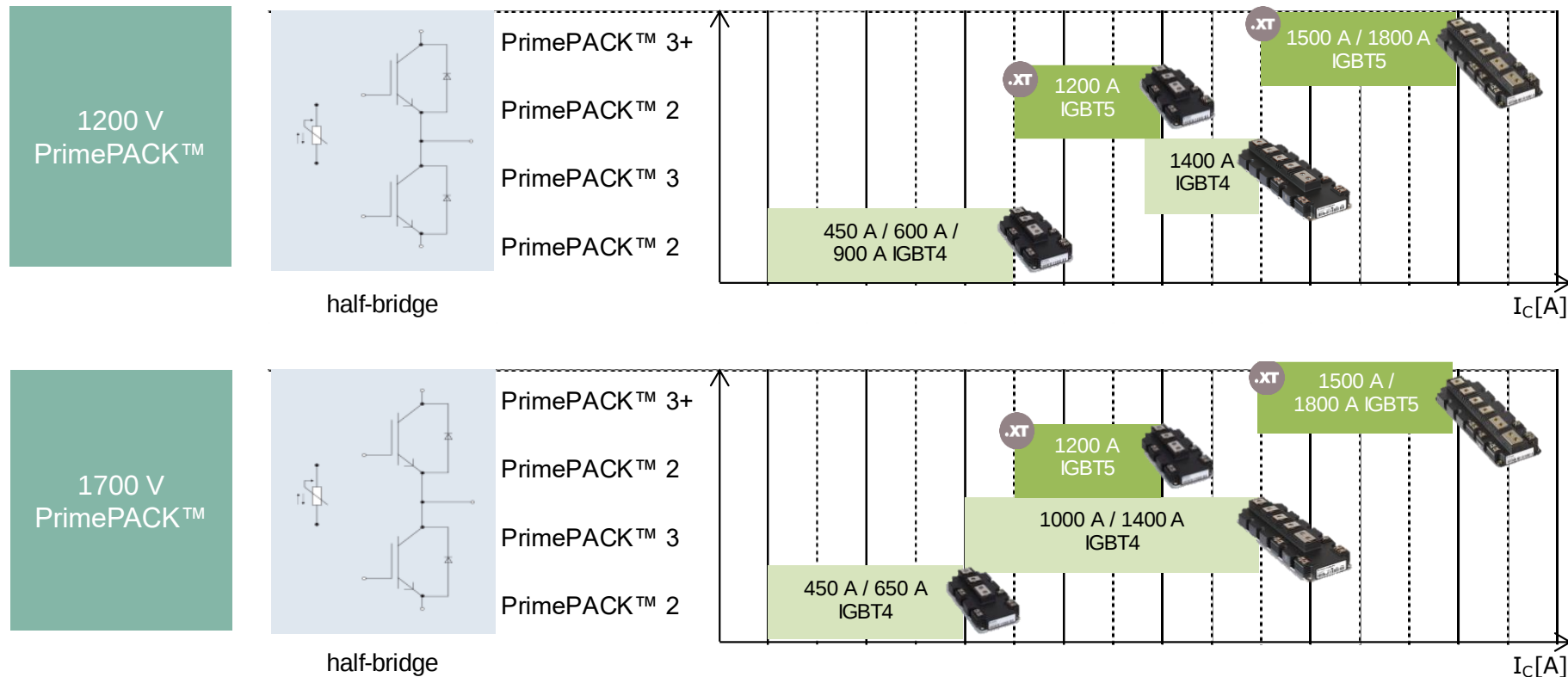
[click here for more information](#)

# Power modules for CAV main inverters

# Power modules for CAV main inverters



# PrimePACK™ IGBT5 portfolio extend power range and lifetime



# Automotive HybridPACK™ product families – full performance spectrum of traction inverters for electric vehicles



| ~ Power Class*             |          | 60 kW                                                                                                                                 | Medium<br>80 kW                                                                                                                         | 100 kW                                                                                                                           | 120 kW                                                                                                                                                                                                      | High<br>150 kW                                                                                                                                    | 180 kW                                                                                                                                     | Ultra high<br>>180 kW |
|----------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| HybridPACK™<br>Drive Gen 1 | 1200V    |                                                                                                                                       |                                                                                                                                         |                                                                                                                                  |                                                                                                                                                                                                             | <br><b>Performance 1200 V</b><br><a href="#">FS380R12A6T4B</a> |                                                                                                                                            |                       |
|                            | 750V     |                                                                                                                                       | <br><b>Flat Base</b><br><a href="#">FS660R08A6P2FB</a> |                                                                                                                                  | <br><b>Wave</b><br><a href="#">FS770R08A6P2B</a>                                                                          | <br><b>PinFin</b><br><a href="#">FS820R08A6P2B</a>             | <br><b>Performance</b><br><a href="#">FS950R08A6P2B</a> |                       |
| HybridPACK™ DC6            | 705/750V | <br><b>Flat Base</b><br><a href="#">FS400R07A3E3</a> | <br><b>Wave</b><br><a href="#">FS400R07A3E3_H6</a>     | <br><b>DC6i</b><br><a href="#">FS650R08A4P2</a> | <p><b>Both product families provide scalability by thermal stack</b></p> <ul style="list-style-type: none"> <li>› Same geometry</li> <li>› Same architecture</li> <li>› Adaptation of the cooler</li> </ul> |                                                                                                                                                   |                                                                                                                                            |                       |

\* Inverter power depends on individual system design of our customers

# Evaluation Tools HybridPACK™ Drive - enabling customer designs



## Evaluation Gate Driver Board

- › Compatible to all HybridPACK™ Drive EDT2 750 V modules and 1200 V modules
- › 6 channel driver PCB
- › With latest Infineon EiceDRIVER™ Sense & Boost



## Inverter Evaluation Kit for HybridPACK™ Drive & HYBRID KIT DRIVE SENSE

- › FS820R08A6P2(L)B
- › With gate driver board, DC link capacitor, aluminum cooler, logic board and LEM current sensor



## Inverter Evaluation Kit for “HybridPACK™ Drive 1200 V

- › FS380R12A6T4B
- › With gate driver board, DC link capacitor, reference aluminum cooler, logic board



## HybridPACK™ Drive Thermal Test PCB

- › Creepage distance designed for up to 800 V working voltage
- › Easy to Use: Electric isolation due to optical measurement
- › Total overview vs. single points thermo-element measurement

# Gate drivers



# Infinion automotive gate driver as part of a functional safety concept

## Automotive EiceDRIVER™ SIL and Boost



### Functional safety at Infineon

- › Organization adapted to comply with ISO26262 requirements
- › ASIL C/D is a requirement at system / function level, not at IC level.
- › IFX provides solutions making the implementation of a safety concept more cost efficient



### EiceDRIVER™ SIL - 1EDI20xxAS provides a variety of safety features

- › Short circuit protection e.g.: DESAT & CSENSE
- › Integrated monitoring & supervision functions with failure injection (verification mode)
- › Programmable two-level turn on/off or switchable DESAT blanking times
- › Miller clamp output or digital isolated channel
- › ISO26262 ready or compliant



### EiceDRIVER™ BOOST 1EBN100xAE

- › Supports ASC & ACLI strategies
- › Up to 15 A source/sink current
- › Supports two-level switching
- › Integrated clamping enables split output for less complex circuitry



# Customer enablement: HybridKIT™ for HybridPACK™ and high-voltage IGBT gate driver



**HybridKIT™ for HybridPACK™**

## Features:

The new HybridKIT™ drive is an easy to use evaluation kit for a B6-bridge xEV main inverter application. It is equipped with the latest Infineon power module setting a new market benchmark:

[HybridPACK™](#) drive [FS820R08A6P2B](#).

The evaluation kit HybridKIT™ drive is intended to demonstrate the outstanding performance of the latest Infineon IGBT generation EDT2 combined with the latest module package technology [HybridPACK™](#) drive.



**1EDI2002AS EVALKIT**

**1EDI2010AS EVALKIT**

## Features:

- › Full functionality of EiceDRIVER™ SIL or EiceDRIVER™ SENSE available (1EDI2002AS, 1EDI2010AS)
- › Testing and configuring of all 1EDI2002AS/1EDI2010AS features
- › Simple IGBT connection and testing
- › Includes GUI for user friendly operation
- › 12 V DC input power supply
- › Communication via AURIX™ TC277

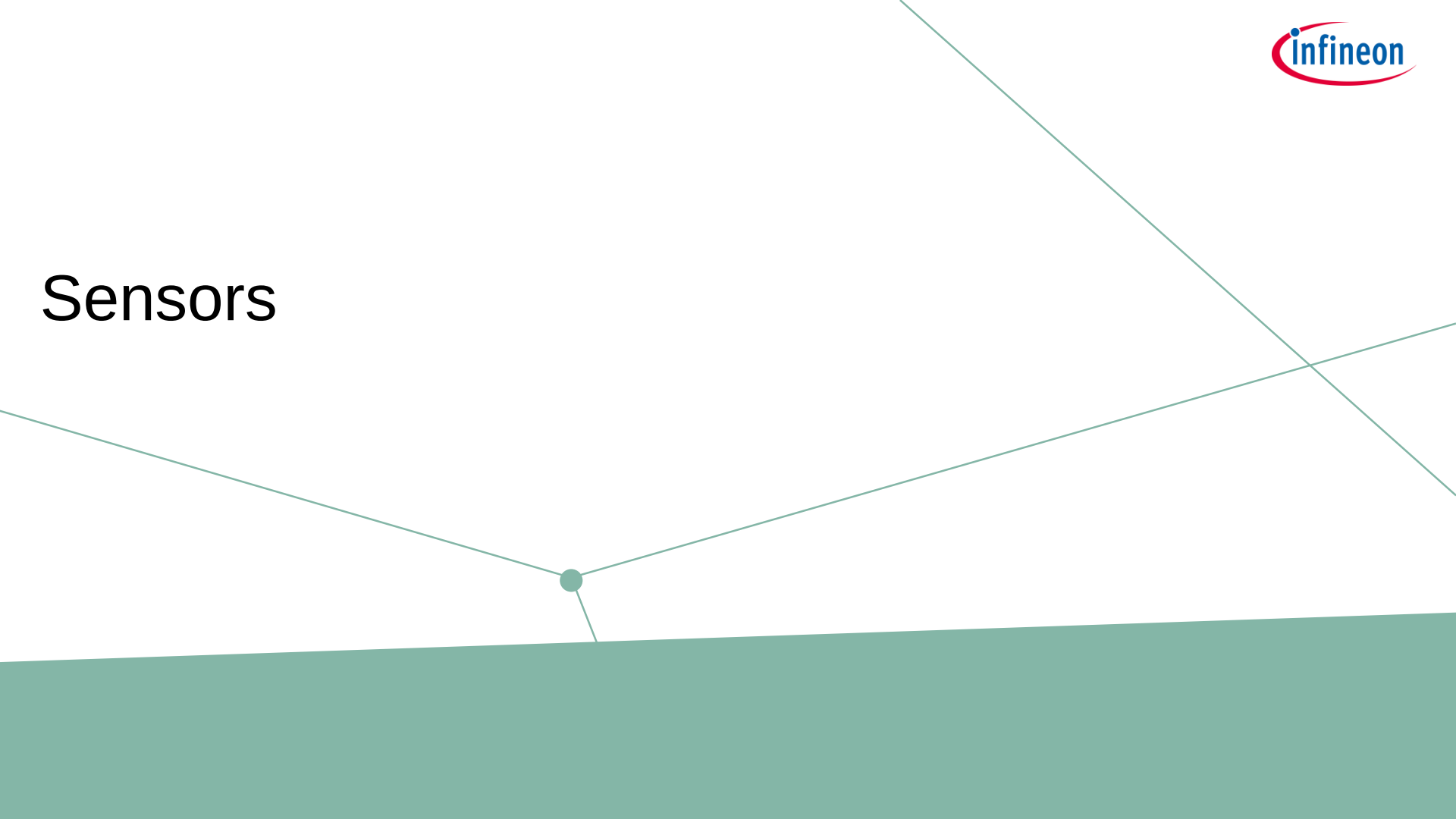
## Benefits:

- › Support for active short circuit strategies also in combination with the EiceDRIVER™ BOOST (1EBN1001AE)
- › Cost effective implementation of ASIL C/D on system level
- › Software Driver (source code) for 1EDI2002AS

## Benefits:

- › Embedded ADC reduces significantly system costs
- › Two-level turn-on increases the system's efficiency

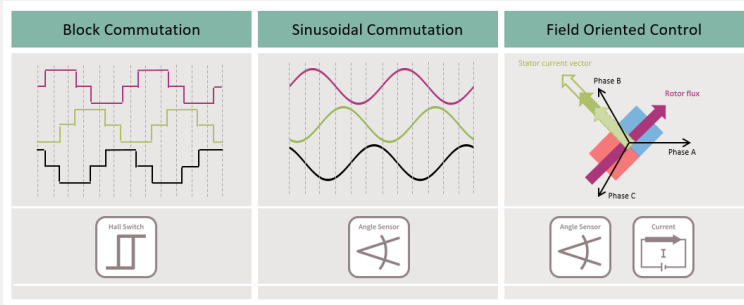
Sensors



# XENSIV™ angle-sensors in electrification for drives in CAV

## Broad product portfolio for all kind of electric motor commutation types

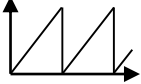
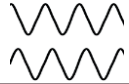
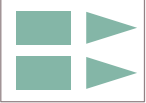
- › Wide portfolio of magnetic position sensors
- › Offering Hall, GMR, AMR and TMR sensors
- › Digital and analog interfaces for angle sensors available
- › Suitable for all commutation types for motor control
- › ISO ready and ISO compliant versions
- › Supporting up to ASIL-D on system level



## Product examples & benefits:

- › TLE5501 – analog TMR sensor
  - Low current consumption (~2 mA)
- › TLE5014 – digital GMR sensor
  - Highest sensitivity
  - SPC, PWM, SENT and SPI interface
  - Accuracy: <1°
- › TLE4961/4/8
  - Low power consumption
  - Small SOT23 package

# The growing Infineon angle sensor portfolio – A perfect fit for rotating applications

|                                                                                                                                                                                                                      | iAMR                          | iGMR                                                                                              | iTMR    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|---------------------------------------------------------------------------------------------------|---------|
|  <p>Digital angle</p>  <p>0110100</p>               |                               | TLI5012B<br>TLE5012B(D)<br>TLE5014S16(D)<br>TLE5014P16(D)<br>TLE5014C16(D)<br><b>TLE5014SP(D)</b> |         |
|  <p>Digital sin/cos</p>  <p>0110100<br/>1101010</p> |                               | TLE5011                                                                                           |         |
|  <p>Analog sin/cos</p>                              | TLE5109A16(D)<br><br>TLE5309D | TLE5009<br>TLE5009A16(D)                                                                          | TLE5501 |

(D) = Single and dual die  
D = Dual die only

# 32-bit AURIX™ Microcontroller based on TriCore™

# AURIX™ addresses CAV requirements and challenges

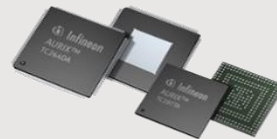
## Performance



## Functional safety & security



## Scalability



## Enablement



- › **Multi-core technology**
- › Hardware accelerators
- › Floating-point unit

- › Platform safety concept: ISO26262
- › **IEC 61508 documentation**
- › 32-bit programmable security hardware

- › Pinout compatibility
- › **Scalable Hardware:**
- › 1 – 6 TriCore™ cores
- › 133 – 300 MHz
- › 512 kB – 16 MB Flash
- › 48 kB – 7 MB RAM

- › Expert tools
- › Free tool chain
- › Technical experts
- › Reference designs
- › **Preferred design house support**

Long-term supply availability and supply security

Automotive quality standards

OPTIREG™ PMIC power supply is the perfect fit for AURIX™

# AURIX™ TC3xx – portfolio for powertrain applications

|                                         |             |          |            |         |          |           |           |
|-----------------------------------------|-------------|----------|------------|---------|----------|-----------|-----------|
| <b>9xA Series</b><br>6 x 300MHz - 16 MB | Inverter    |          |            |         |          | TC397XA   |           |
| <b>9x Series</b><br>6 x 300MHz - 16 MB  | DC/DC & OBC |          |            |         |          | TC397Q/X  | TC399X    |
| <b>Ex Series</b><br>4 x 300MHz - 12 MB  | EMS         |          |            |         |          | TC3EQ     |           |
|                                         | TCU         |          |            |         |          |           |           |
| <b>8x Series</b><br>4 x 300MHz - 10MB   | BMS         |          |            |         |          | TC387Q    | TC389Q    |
| <b>7 Series</b><br>3 x 300MHz - 6MB     |             |          |            |         |          | TC377TX   |           |
| <b>7x Series</b><br>3 x 300MHz - 6MB    |             |          |            |         | TC375T   | TC377T    |           |
| <b>6x Series</b><br>2 x 300MHz - 4MB    |             |          | TC364D     | TC366D  | TC365D   | TC367D    |           |
| <b>Ax Series</b><br>4 x 300MHz - 4MB    |             |          |            |         |          | TC357QA   |           |
| <b>5xA Series</b><br>3 x 300MHz - 4MB   |             |          |            | TC356TA |          | TC357TA   |           |
| <b>3xA Series</b><br>2 x 300MHz - 2 MB  |             |          |            | TC336DA |          | TC337DA   |           |
| <b>3x Series</b><br>1 x 200MHz* - 2 MB  | TC332L      | TC333L   | TC334L     | TC336L  |          | TC337L    |           |
| <b>2x Series</b><br>1 x 200MHz* - 1 MB  | TC322L      | TC323L   | TC324L     |         |          | TC327L    |           |
| Flash<br>Package                        | TQFP 80     | TQFP 100 | T/LQFP 144 | BGA 180 | LQFP 176 | LFBGA 292 | LFBGA 516 |

## MCU scalability

- › Performance & flash
- › Software compatibility
- › Pin-compatibility

## Safety/security concept

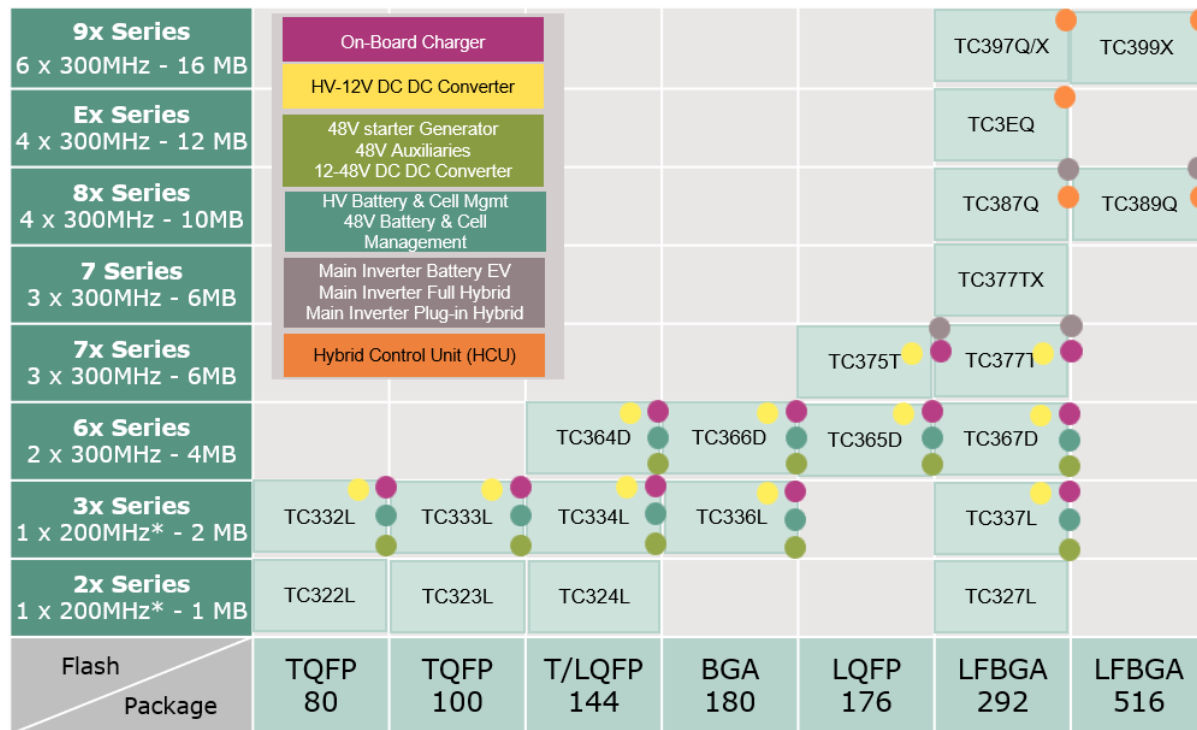
- › ISO26262 ASIL-D compliance of all devices
- › EVITA full hardware security support on all devices

## Connectivity

- › Ethernet: up to 2x 1Gbit/s
- › CAN FD: up to 16 ch
- › LIN: up to 24 ch
- › eMMC IF: for external flash
- › IPC: up to 2x 320Mbit/s

L - Single Lockstep Core    Q - Quadruple Core  
 D - Dual Core    X - Sextuple Core  
 T - Triple Core

# AURIX™ TC3xx family portfolio covering all applications for eMobility



## MCU scalability

- › Performance & flash
- › Software compatibility
- › Pin-compatibility

## Safety/security concept

- › ISO26262 ASIL-D compliance of all devices
- › EVITA full hardware security support on all devices

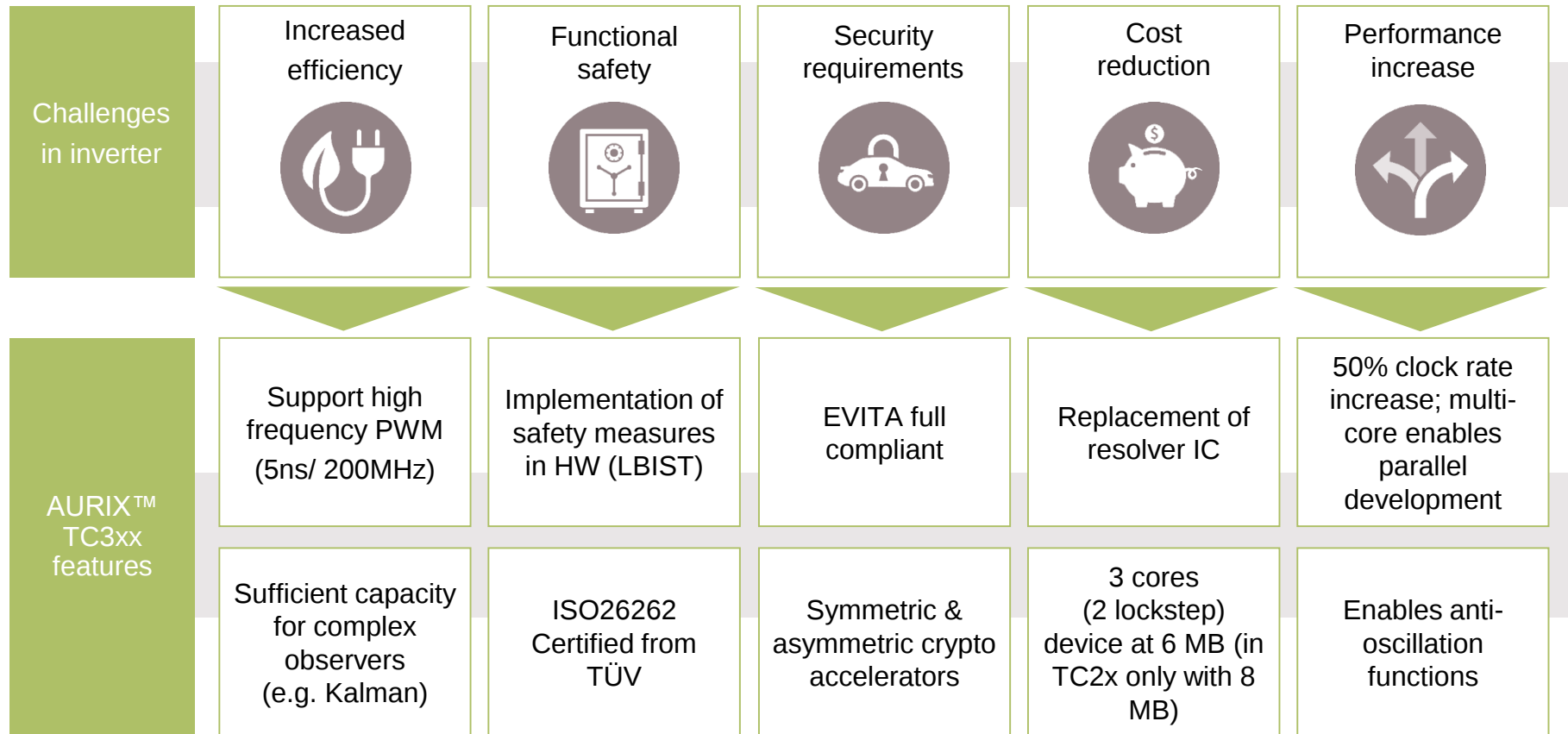
## Connectivity

- › Ethernet: up to 2x 1Gbit/s
- › CAN FD: up to 16 ch
- › LIN: up to 24 ch
- › eMMC IF: for external flash
- › IPC: up to 2x 320Mbit/s

AURIX™ TC3xx has the most extensive eMobility MCU portfolio available today

L - Single Lockstep Core    Q - Quadruple Core  
D - Dual Core    X - Sextuple Core  
T - Triple Core

# AURIX™ TC3xx features solve challenges for Inverter



# Customer enablement: AURIX™ kits



## Arduino Shield Buddy

- › The AURIX™ TC275 / TC375 ShieldBuddy follows the Arduino standard
- › Compatible with 100's of Arduino application shields
- › Evaluation licenses available
- › Ideal for getting started on a high end real time embedded industrial or automotive application

[KIT\\_AURIX\\_TC275\\_ARD\\_SB](#)

[KIT\\_AURIX\\_TC375\\_ARD\\_SB](#)



## AURIX™ TFT

- › Low cost board for early evaluation with limited access to signals
- › Additional touchscreen display for convenient handling
- › TFT board available

[KIT\\_AURIX\\_TC2xx\\_TFT](#)



## AURIX™ TriBoard

- › Full evaluation board for development to write and debug your 1<sup>st</sup> programs
- › Includes Getting Started advice, free TriCore™ Entry Tool Chain, technical documentation, compiler and debugger
- › TriBoard available for

[KIT\\_AURIX\\_TC2xx\\_TRB](#)



## AURIX™ Lite Kit

- › AURIX™ TC275 Device in LQFP-176 package
- › Use of Arduino Uno/ compatible platform
- › FTDI based Debugger with micro USB
- › AURIX™ kit also for AURIX™ TC3xx based on the same package

[KIT\\_AURIX\\_TC275\\_LITE](#)

# Perfect fit for AURIX™ Supply

## OPTIREG™ PMIC - TLF35584



### Key features

- › Development acc. ISO26262
- › Vin: 3V .. 40V
- › Buck/Boost-Pre-Regulator
  - IQ = 1.3A; f: 300kHz-2.5MHz
- ›  $\mu$ C-Supply: 3.3V/5V @ 600mA
- › Reference-LDO: 5V @ 150mA ( $\pm 1\%$ )
- › 2x Tracker: 5V @ 150mA
- › Communication-Supply: 5V @ 200mA
- › StandBy-LDO: 3.3V/5V @ 10mA
- › EN/Wake (T15 and CAN/FlexRay™)
- › SPI
- › Safety Features
  - Multiple bandgap (supply vs V-monitoring)
  - UV/OV-Monitoring, ERR-Monitoring
  - Functional-WD & Window-WD
  - Safe State Control/Secondary Safety Path
  - Electrically isolated/HV interconnects
  - Built In Self Test

### Packages



PG-VQFN-48

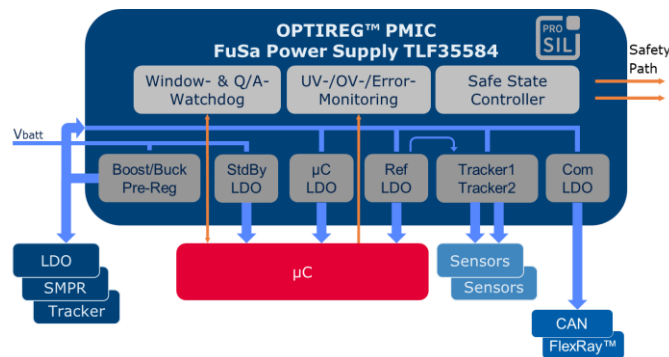


PG-LQFP-64

### Applications

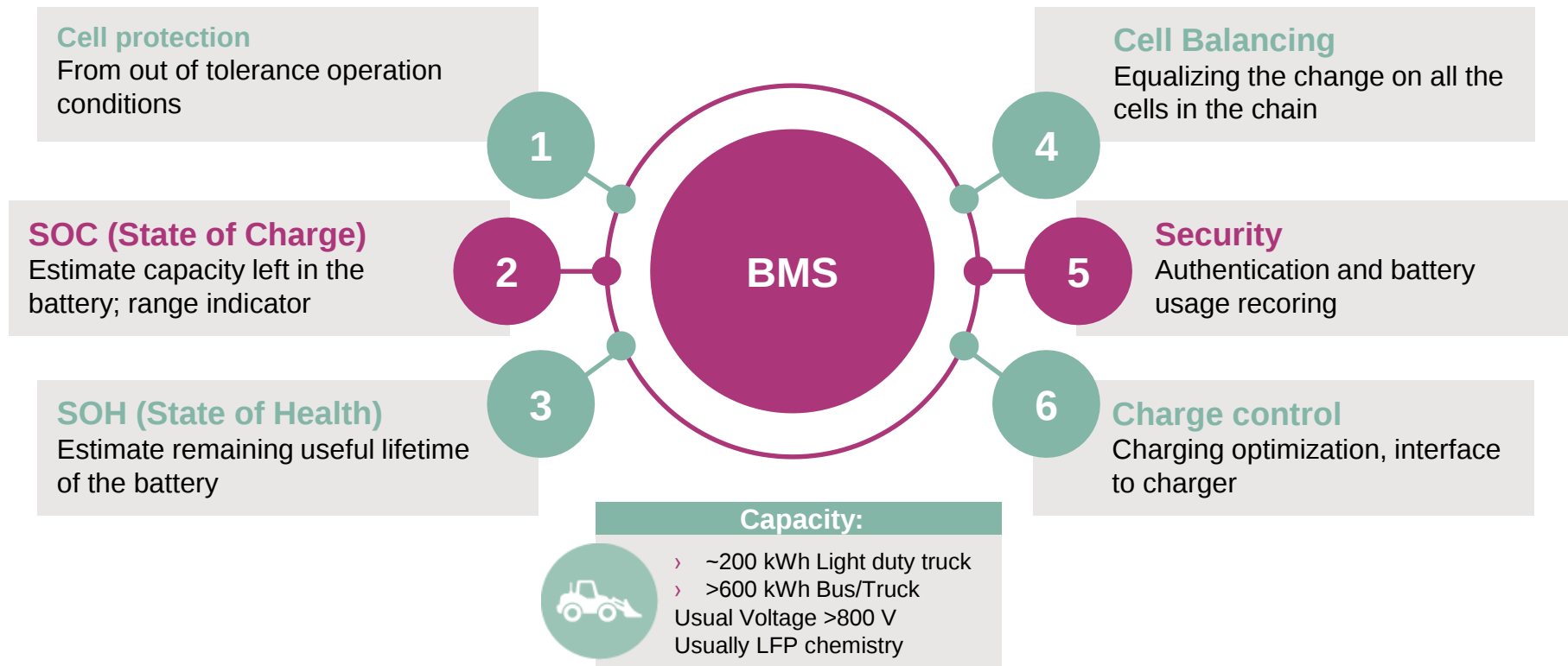
- › EPS, Brake, Suspension, Domain Control
- › Engine Management, Transmission, xEV
- › ADAS

### Application block diagram



# Battery management system in CAV

Every Li-Ion battery needs a “Battery management system”



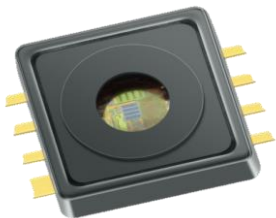
# BAP sensors for Battery Management Systems (BMS)



- › BMS Thermal Runaway

## Products

- › Analogue interface: KP236N6165
- › Digital interface: KP256, KP253



KP25x – barometric air pressure sensor with digital interface

## Features

- › 10-bit & 12bit\* SPI interface for  $\mu\text{C}$
- › High accuracy absolute pressure sensing
- › Integrated temperature sensor
- › Operating temperature up to  $140^{\circ}\text{C}$
- › Customer specific transfer functions
- › Self diagnosis capability
- › Automotive qualified (AEC-Q100)

# Agenda

---

- 1 Market trends in CAV
- 2 Challenges and Infineon solutions
- 3 Infineon components for electrification in CAV
- 4 **Focus product tables**
- 5 Summary

# Technology / Market solutions: Links to product pages

## Microcontroller

### [AURIX™](#)

- ATV Quality & Temp
- Functional Safety
- Cyber Security & Authentication

### [TC2xx](#)

### [TC3xx](#)

## OPTIREG™ PMIC

### [OPTIREG™](#)

### [TLF35584 Family](#)

- Multiple output PMIC for safety-relevant applications supplying  $\mu$ C, transceivers and sensors
- Efficient and flexible pre-/post regulator concept.

## Sensor

### [Hall Sensors](#)

- High redundancy on one chip
- Premium functional safety compliant systems up to ASIL-D

### [TLE4999I3](#)

- Developed compliant to ISO 26262 for safety requirements rated up to ASIL-D

### [Angle Sensors](#)

- Giant Magneto Resistance (GMR) – based principle

### [Absolute Pressure Sensors](#)

### [KP253](#)

- The KP253 is a miniaturized Digital Barometric Air Pressure Sensor IC based on a capacitive principle

## Driver ICs

### [Automotive:](#)

### [TLE9180D-21K](#)

### [TLE9180D-31QK](#)

- Advanced gate driver ICs dedicated to controlling 6 external N-channel MOSFETs forming an inverter for high current 3-phase motor drive applications in the automotive sector.

## OptiMOS™ 80 V

### [OPTIMOS™ 80 V](#)

### [IAUC100N08S5N031](#)

### [IAUS165N08S5N029](#)

- TOLL, TOLG and SS08 packages with several advantages

## Transceivers

### [Automotive CAN Transceivers](#)

- For flexible data rates up to 2 Mbit/s

### [TLE9250XSJ](#)

## Automotive EiceDRIVER™

### [Automotive Gate Driver ICs](#)

### [1EDI2002AS](#)

## Modules

### [Automotive IGBT Modules](#)

### [FS380R12A6T4B](#)

### [FF450R08A03P2](#)

### [IGBT Modules](#)

### [FF600R12ME4 B11](#)

### [FF900R12ME7 B11](#)

# Agenda

---

- 1 Market trends in CAV
- 2 Challenges and Infineon solutions
- 3 Infineon components for electrification in CAV
- 4 Focus product tables
- 5 Summary

# Summary: Get your share with Infineon's system solution excellence



- › **CAV** includes truck, buses, forklift, agriculture and construction vehicles
- › Infineon is responding to the megatrend **Electrification (CO2 regulations)** with our system solution excellence (TCO)

- › Long term **growth drivers**: electrification and autonomous driving; a truck remains a truck
- › Growing production of CAV with **growing electronic content**

- › **Innovation, safety and reliability**
- › Long-term **availability** of products & long-term **business**
- › Infineon has the **largest portfolio** for the CAV market: **Sense – Control – Actuate & Enablement** solutions



Further information on the dedicated website

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

- › Application notes
- › Presentations
- › Articles
- › Boards
- › eLearnings
- › Eval kits
- › Online simulation tools & product finders
- › Podcasts
- › Reference designs
- › White papers



Part of your life. Part of tomorrow.