AURIX Knowledge Lab 2021

Battery management in control!

AURIX™ safety & security introduction and AUTO PSoC™ ecosystem

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AURIX™: TC2xx Scalable Family
From low cost to high performance applications

Flash	TQFP 80	TQFP 100	T/LQFP 144	LQFP 176	LFBGA 292	BGA 416	LFBGA 516
TC29x 8 MB	🔒				TC297T 300MHz	TC298T 300MHz	TC299T 300MHz
TC27x 4 MB	🔒			TC275T 200 MHz	TC277T 200MHz		
TC26x 2.5 MB			TC264D 200 MHz	TC265D 200 MHz	TC267D 200 MHz		
TC23x 2 MB	🔒	TC233L 200 MHz	TC234L 200 MHz		TC237L 200 MHz		
TC22x 1 MB	TC222L/S 133 MHz	TC223L/S 133 MHz	TC224L/S 133 MHz				
TC21x 512 kB	TC212L/S 133 MHz	TC213L 133 MHz	TC214L/S 133 MHz				
Package	TQFP 80	TQFP 100	T/LQFP 144	LQFP 176	LFBGA 292	BGA 416	LFBGA 516

🔒 Devices with HSM

Single Core (S) Single Lockstep Core (L), Dual Core (D) Triple Core (T)

↕ Upgrade/Downgrade path with pin compatible packages

PRO SIL PRO-SIL™: Safety supporting features

MCU Scalability
› Performance & Flash
› Software and Pin compatibility
› Diverse timer architecture

Power Consumption
› On-chip DC/DC high-efficiency power supply

Safety Concept
› PRO-SIL™ ISO26262 / IEC61508 compliance
› HW redundancy options

Security Concept
› Selected devices with Hardware Security Module (HSM)

Availability
› All devices are in mass production

Tools & Boards
› Multiple options available

AURIX™ TC3xx Architecture Evolution (enhancements vs. AURIX™)

Performance

› New TriCore™ 162 generation
› New instructions
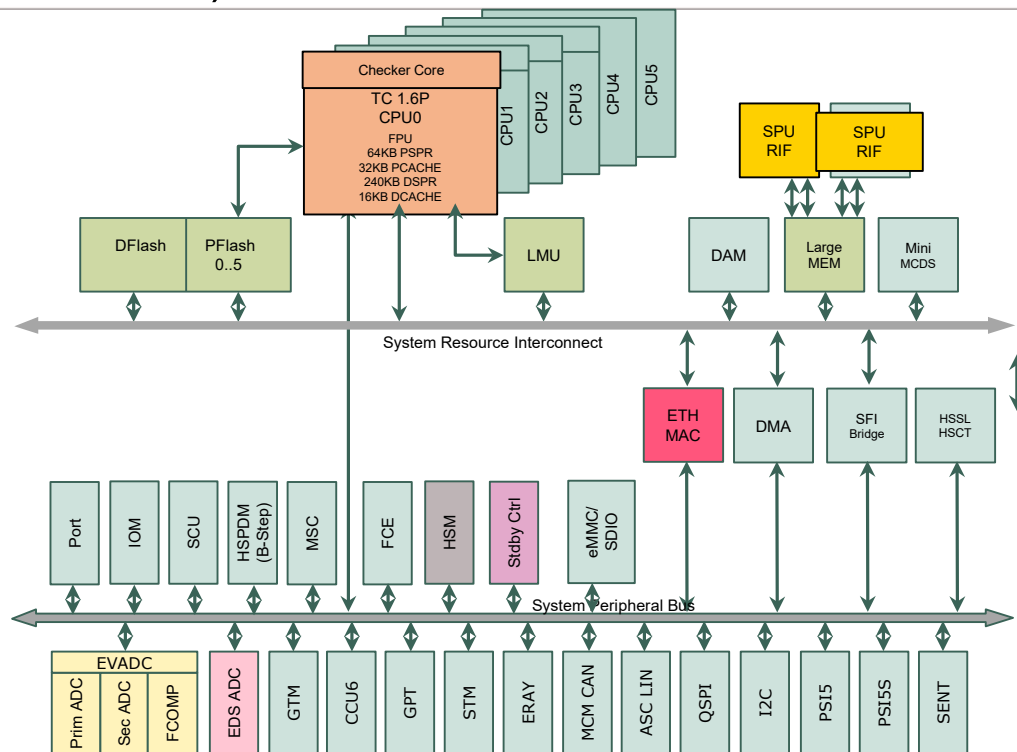› up to 6 CPUs @300MHz
› New direct Flash access path

Memories

› Larger SRAM
› SRAM/Flash ratio increased
› enhanced MPU

ADC

› Improvement of existing ADC
› Reduction of capacitive load

Delta-Sigma:

› enhanced concept

ADAS

› New SPU concept

Safety

› LBIST
› MBIST upgrade

Ethernet

› 1GBit/s ETH
› QoS services

IO Pads

› all 5V/3.3V

HSM: Full Evita compliance

› New accelerators ECC256 / SHA256
› Available on all devices

Standby Control Unit

› Low power modes
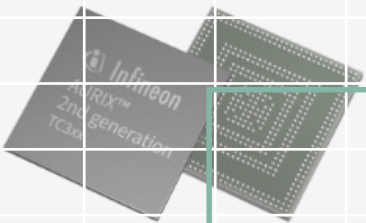
AURIX™ TC3x – Portfolio
From low-cost to high-performance applications

Infineon

Control and Actuate
Sense and Compute

Flash/ CPUs \ Package	TQFP 80	TQFP 100	T/LQFP 144	BGA 180	LQFP 176	BGA 233	LFBGA 292	LFBGA 516
9xA Series 6 x 300MHz - 16 MB								
9x Series 6 x 300MHz - 16 MB								
Ex Series 4 x 300MHz - 12 MB								
8x Series 4 x 300MHz - 10MB								
7xX Series 3 x 300MHz - 6MB								
7x Series 3 x 300MHz - 6MB								
6x Series 2 x 300MHz - 4MB								
5xA Series 3 x 300MHz - 4MB								
3xA Series 2 x 300MHz - 2 MB								
3x Series 1 x 300MHz - 2 MB								
2x Series 1 x 300MHz - 1 MB								

Data Fusion / Front LRR / High-end EMS / Domain Control / Gateway
- TC397XA 300MHz
- TC397X 300MHz, TC399X 300MHz
- TC3E7Q 300MHz

Advanced Braking / EMS, Tranmsission, Inverter, BMS / High-end body control / Domain control, Telematics
- TC387Q 300MHz, TC389Q 300MHz
- TC377TX 300MHz
- TC375TP 300MHz, TC377TP 300MHz
- TC364D 300MHz, TC366D 300MHz, TC365D 300MHz, TC367D 300MHz

Hi-res front radar / Corner high
- TC356TA 300MHz, TC357TA 300MHz

Front radar / Corner radar
- TC336DA 300MHz, TC337DA 300MHz

Braking, EPS, Airbag, BMS, OBC, DCDC / 4WD, eClutch / Host control, Telematics
- TC332L 200MHz*, TC333L 200MHz*, TC334L 200MHz*, TC336L 200MHz*, TC337L 200MHz*
- TC322L 160MHz, TC323L 160MHz, TC324L 160MHz, TC327L 160MHz*

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

Connnectivity
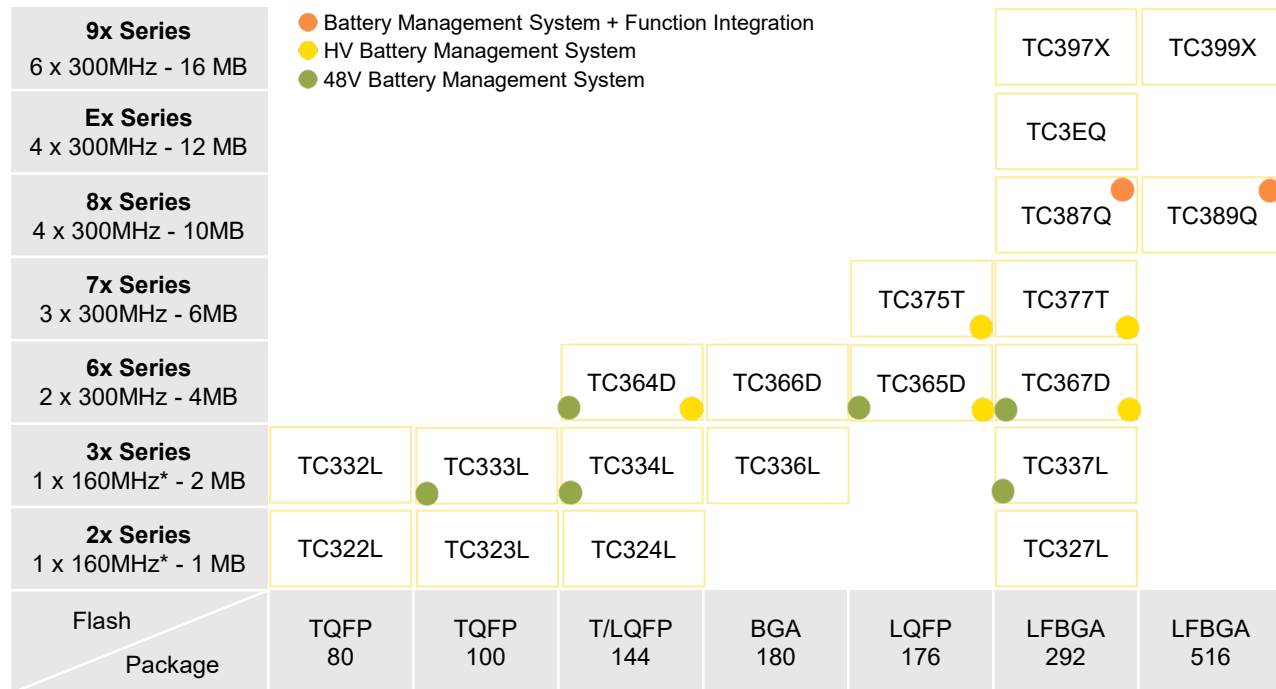› Ethernet: up to 2x 1GBit/s
› CAN FD: up to 16 ch
› LIN: up to 24 ch
› eMMC IF: for external Flash
› IPC: up to 2x 320MBit/s

L - Single Lockstep Core
D - Dual Core
T - Triple Core
Q - Quadruple Core
X - Sextuple Core
* 300MHz Option

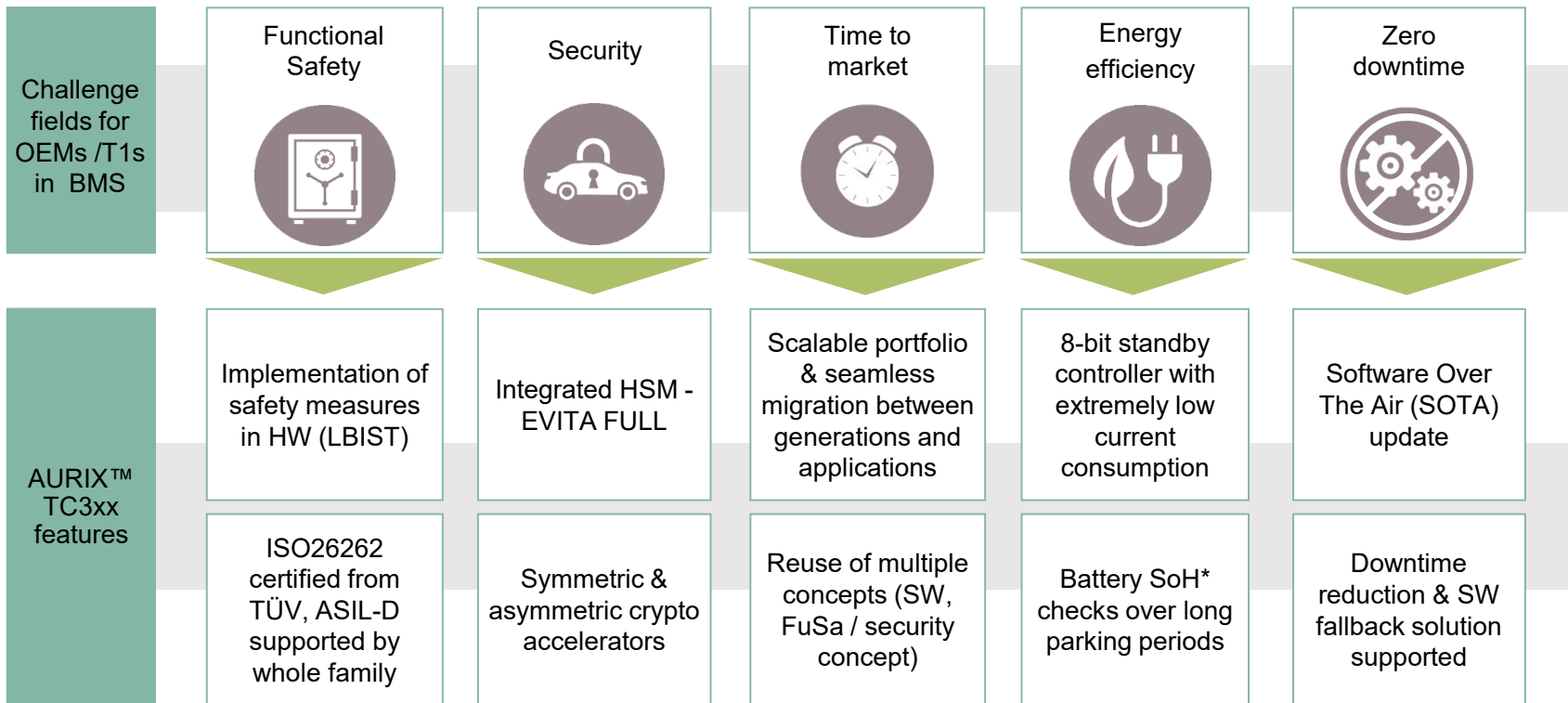# AURIX™ TC3xx – Portfolio for Powertrain Applications
Devices from low-cost to high-performance suit different BMS requirements

- 🟠 Battery Management System + Function Integration
- 🟡 HV Battery Management System
- 🟢 48V Battery Management System

Flash / Package	TQFP 80	TQFP 100	T/LQFP 144	BGA 180	LQFP 176	LFBGA 292	LFBGA 516
9x Series 6 x 300MHz - 16 MB						TC397X	TC399X
Ex Series 4 x 300MHz - 12 MB						TC3EQ	
8x Series 4 x 300MHz - 10MB						TC387Q 🟠	TC389Q 🟠
7x Series 3 x 300MHz - 6MB					TC375T 🟡	TC377T 🟡	
6x Series 2 x 300MHz - 4MB			TC364D 🟢 🟡	TC366D	TC365D 🟢	TC367D 🟡 🟢 🟡	
3x Series 1 x 160MHz* - 2 MB	TC332L	TC333L 🟢	TC334L 🟢	TC336L		TC337L 🟢	
2x Series 1 x 160MHz* - 1 MB	TC322L	TC323L	TC324L			TC327L	

*300MHz option available

Key AURIX™ TC3xx feature by application	BMS
High Multicore Performance	☑
Rich peripheral set	
CAN-FD (up to x2)	☑
High RAM content	☑
Timer across family	
Low power modes	☑
Safety (ASIL-D)	☑
Security	☑
Resolver-less solution	
SOTA support	☑
High temp. support	
High RAM/flash ratio	☑

# AURIX™ TC3xx solves challenges at tier1s and OEMs for Battery Management Systems (BMS)

Challenge fields for OEMs /T1s in BMS	Functional Safety	Security	Time to market	Energy efficiency	Zero downtime

AURIX™ TC3xx features	Implementation of safety measures in HW (LBIST)	Integrated HSM - EVITA FULL	Scalable portfolio & seamless migration between generations and applications	8-bit standby controller with extremely low current consumption	Software Over The Air (SOTA) update
	ISO26262 certified from TÜV, ASIL-D supported by whole family	Symmetric & asymmetric crypto accelerators	Reuse of multiple concepts (SW, FuSa / security concept)	Battery SoH* checks over long parking periods	Downtime reduction & SW fallback solution supported

*SoH: State-of-Health

AURIX™ with strong footprint in Battery Management Systems with additional growth expected

MCUs functions for Battery Management Systems (BMS)
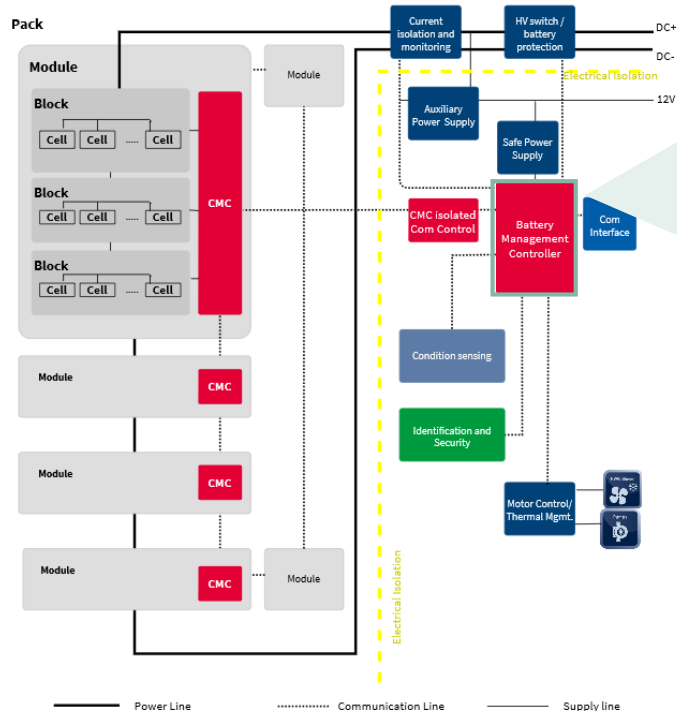
- **Battery monitoring**
  Continous controlling of critical cell characteristics (such as voltage, current, temperature) and calculation of state of charge (SoC) and state of health (SoH)

- **Battery protection**
  Safety management including crash / mechanical strain detection and Main Switch Control

- **Battery lifetime extension**
  Optimizing battery life and capacity by e.g. limiting deep battery discharge and actively managing battery temperature

Why AURIX™?

Strong engagement with all relevant market players along the BMS supply chain

› **Strong position at EU & Chinese OEMs** for 48V and high voltage systems

› **Scalable family concept** enables re-use across different battery management systems

› **Strong product roadmap** provides access to innovation

› **Proven quality & powertrain knowhow** from conventional applications

› **Harmonized SW and tool chains** between different applications enables SW re-use

› **ISO26262 certified** from TÜV

AURIX™ Functional Safety concept

Holistic approach with a multitude of hardware measures

HW designed for functional safety

Superior Lockstep CPU with Anti-core in inverse logic
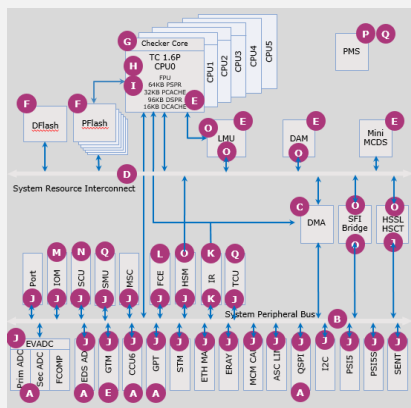
Core

CPU

CbⴖU

Anti-Core
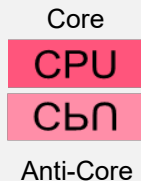
Holistic safety concept in core, memories, peripherals, buses
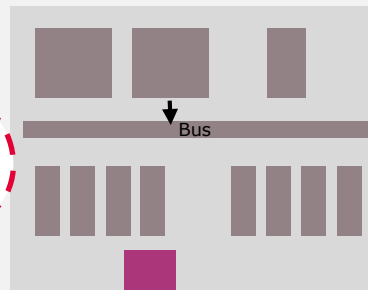
SMU for alarm and fault management in one control point

3-layer access protection:
- Memories
- Peripherals
- Global registers

Much more than just a safety island!!

● Safety measures

VS.

A	Redundant, spatial separated peripherals
B	Safe SPB
C	Safe DMA
D	Safe SRI
E	SRAM ECC

F	Flash ECC
G	Lockstep core
H	CPU self tests (90% Latent Fault Metric)
I	Memory protection core
J	Register access protection
K	Safe Interrupt Processing

L	Flexible CRC Engine (FCE)
M	IO Monitor
N	Clock Monitoring
O	E2E protection
P	Power Supply Monitoring
Q	Self Test

Everything documented

50k lines FMEDA
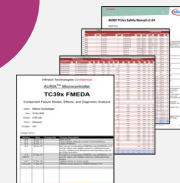
Comprehensive safety manual & Fully Configurable FMEDA

› Provides all relevant information necessary for safety analysis

› Can by tailored to match the user configurations

AURIX™ kits – Evaluation and starter Kits

Lets get started!

AURIX™TC275 Lite Kit

new · €30

Supported by ADS

› AURIX™ TC275 Device in LQFP-176 package
› FTDI based Debugger with micro USB
› Use of Arduino Uno/ compatible platform
› **KIT_AURIX_TC275_LITE - Infineon Technologies**

Arduino Shield Buddy

€99

Supported by ADS

› The Hitex TC275 ShieldBuddy follows the Arduino standard
› Compatible with 100's of Arduino application shields
› Evaluation licenses available
› **KIT_AURIX_TC275_ARD_SB**

AURIX™ TFT

€149

Partially Supported by ADS

› Low cost board for early evaluation with limited access to signals
› Additional touchscreen display for convenient handling
› TFT board available for every silicon
› **KIT_AURIX_TC2xx_TFT**

AURIX™ TriBoard

€350+

› Full evaluation board for development to write and debug your 1st programs
› Includes Getting Started advice, free TriCore™ Entry Tool Chain , technical documentation, compiler and debugger.
› TriBoard available for every silicon
› **KIT_AURIX_TC2xx_TRB**
› **KIT_AURIX_TC3xx_TRB**

AURIX™ kits – Evaluation and starter Kits

Lets get started!

new € 45

Supported by ADS

AURIX™TC375 Lite Kit

› AURIX™ TC375 Device

› **Ethernet PHY**

› FTDI based Debugger with micro USB

› Use of Arduino Uno/ compatible platform

› **KIT_A2G_TC375_LITE - Infineon Technologies**

new €99

Supported by ADS

Arduino Shield Buddy

› The Hitex TC375

› ShieldBuddy follows the Arduino standard

› Compatible with 100's of Arduino application shields

› Evaluation licenses available

› **KIT_A2G_TC375_ARD_SB - Infineon Technologies**

€149

Partially Supported by ADS

AURIX™ TFT

› Low cost board for early evaluation with limited access to signals

› Additional touchscreen display for convenient handling

› TFT board available for every silicon

› **32-bit TriCore™ AURIX™– TC3xx - Infineon Technologies**

Coming soon

Supported by ADS

AURIX™ TC334 Lite kit

› AURIX™ TC334 Device

› FTDI based Debugger with micro USB

› Use of Arduino Uno/ compatible platform

PSoC™: One-stop-shop for automotive HMI & smart sensors

Door handle and foot-kick detection

Buttons/sliders

Touchpads

Touchscreens

Optical navigation

Capacitive navigation

Biometrics and navigation

Hands-on detection

Liquid-level sensing

Occupant detection

Intelligent battery sensors

Smart ignition systems

Auto PSoC™ Portfolio

Auto PSoC™ — Arm Cortex-M0/M0+

› PSoC 4 S
- › Arm M0/M0+ MCU, Programmable Analog, Robust HMI, Scalable platform
- › 16KB – 384KB Flash

› PSoC 4 HV MS (Coming Soon)
- › Arm M0+ MCU, Programmable Analog, Robust HMI, **12V LDO, LIN PHY, ASIL-B compliant**
- › 32KB – 512KB Flash

› PSoC 4 HV PA (Coming Soon)
- › Arm M0+ MCU, **Precision Analog, 12V LDO, LIN PHY, ASIL-C compliant**
- › 64KB – 192KB Flash

› PSoC UHV BMS (Coming Soon)
- › Arm M0+ MCU (DCLS), Precision Analog, 110V, BLE, ASIL-D compliant
- › 128KB – 256KB Flash

› TrueTouch and Fingerprint
- › Register-configurable solutions for HMI applications such as touchscreens and fingerprint
- › Very high sensitive capacitive measurements of up to aF (Attofarad)

Scalable PSoC™ 4 Roadmap

From MCU with CAPSENSE™ to Multi-Sense, High Performance Analog, SBC and BLE integration (Public)

infineon

**ISO 26262 compliant - ASIL D
Dual-Core Lockstep**

PSoC UHV Wireless BMS*

**ISO 26262 compliant - ASIL B/C
High Performance Analog, Mixed
Signal with SBC**

HMI & Smart Sensors

PSoC4 HV MS

PSoC4 HV PA

Battery Sensors

PSoC 4 BMS

**ISO 26262 Ready
Entry level MCU
with CAPSENSE™**

PSoC 4100S Max
48 MHz, 384KB/32KB
Multi-Sense, CRYPTO
CAN FD

PSoC 4100L/4200L
48 MHz, 256KB/32KB
UDB, 2x CAN, USB 2.0

PSoC 4100M/4200M
48 MHz, 128KB/16KB
UDB, 2x CAN

PSoC 4100S Plus
48 MHz, 128KB/16KB
CAN

PSoC 4700S Plus
48 MHz, 128KB/16KB
Inductive Sense

PSoC 4100S
48 MHz, 64KB/8KB

PSoC 4100/4200
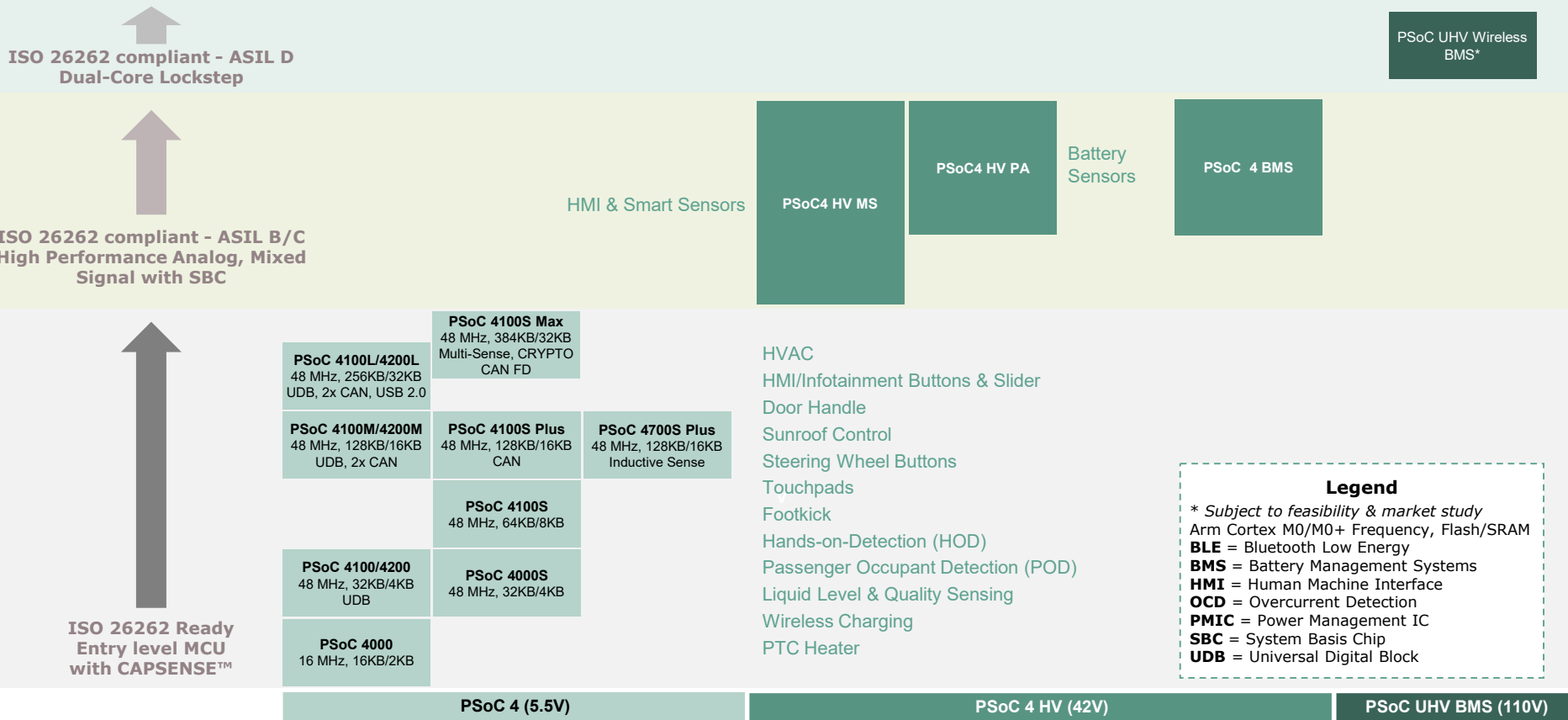48 MHz, 32KB/4KB
UDB

PSoC 4000S
48 MHz, 32KB/4KB

PSoC 4000
16 MHz, 16KB/2KB

HVAC
HMI/Infotainment Buttons & Slider
Door Handle
Sunroof Control
Steering Wheel Buttons
Touchpads
Footkick
Hands-on-Detection (HOD)
Passenger Occupant Detection (POD)
Liquid Level & Quality Sensing
Wireless Charging
PTC Heater

Legend
* Subject to feasibility & market study
Arm Cortex M0/M0+ Frequency, Flash/SRAM
BLE = Bluetooth Low Energy
BMS = Battery Management Systems
HMI = Human Machine Interface
OCD = Overcurrent Detection
PMIC = Power Management IC
SBC = System Basis Chip
UDB = Universal Digital Block

PSoC 4 (5.5V)

PSoC 4 HV (42V)
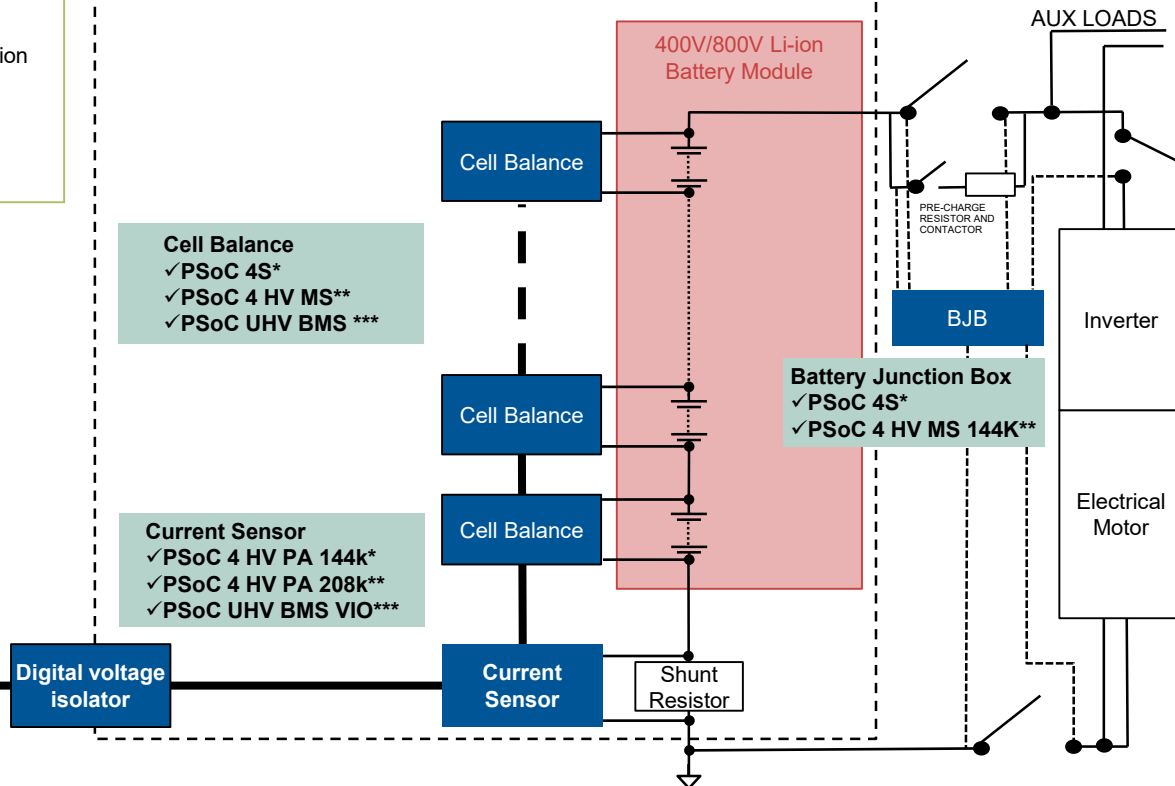
PSoC UHV BMS (110V)

PSoC for BMS

Why PSoC

› **High precision analog performance** with complete analog front-end (ADCs, PGA, digital filter blocks) integration

› Functional safety support up to **ASIL-D** (UHV BMS)

› **Wireless BMS** with BLE: monolithic integration

› MCU integration enabling **distributed BMS**

12V Lead –acid or Li-Ion Battery

Shunt Resistor

IBS / 12V Li BMS

EV ECU

Host MCU
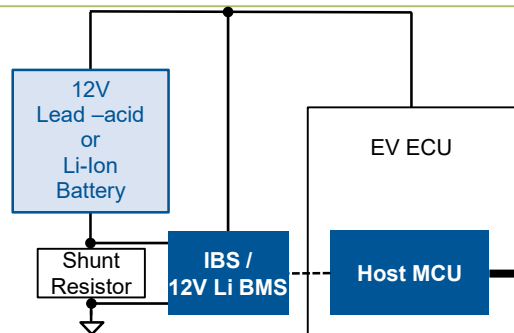
Intelligent Battery Sensor / BMS
✓PSoC 4 HV PA 144k*
✓PSoC 4 HV MS 144k**
✓PSoC 4 12V Li-ion BMS

➤ * Now = In Production / samples
➤ ** Intermediate = Design in 1 year
➤ *** Future = Design in 2 years

Li-ion Battery Pack

400V/800V Li-ion Battery Module

Cell Balance

Cell Balance
✓PSoC 4S*
✓PSoC 4 HV MS**
✓PSoC UHV BMS ***

Cell Balance

Cell Balance

Current Sensor
✓PSoC 4 HV PA 144k*
✓PSoC 4 HV PA 208k**
✓PSoC UHV BMS VIO***

Digital voltage isolator

Current Sensor

Shunt Resistor

AUX LOADS

PRE-CHARGE RESISTOR AND CONTACTOR

BJB

Battery Junction Box
✓PSoC 4S*
✓PSoC 4 HV MS 144K**

Inverter

Electrical Motor