AURIX Knowledge Lab 2021

Battery management in control!

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Agenda

1. AURIX Project Basics
2. AURIX Safety and Security
3. Software Quality and Test
4. PDH, eval boards, trainings and summary of event

1.1 « Introduction and project presentation » **Hitex**	1.2 « Battery management system - Requirements and challenges » **Hitex**	1.3 « Hardware requirements and challenges – Special hardware requirements » **EBV Elektronik**
2.1 « AURIX safety & security introduction and AUTO PSoC ecosystem » **Infineon**	2.2 « Functional Safety with the Hitex SafeTpack» **Hitex**	2.3 « Advantage ECU: Automotive cybersecurity with functional safety » **ESCRYPT**
3.1 « Secure automotive software development from a tools perspective » **TASKING**	3.2 « Security aspects of static code analysis » **Hitex**	3.3 « Hardware-in-the-Loop (HIL) tests with miniHIL » **Hitex**
4.1 « Why work with a Preferred Design House for safety and security » **Hitex**		

EBV Elektronik | An Avnet Company | escrypt SECURITY. TRUST. SUCCESS | hitex EMBEDDED TOOLS & SOLUTIONS | Infineon | TASKING

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EBV + Infineon

EBV is partnering with Infineon for more than 25 years and ranks no.1 within Infineon distribution network

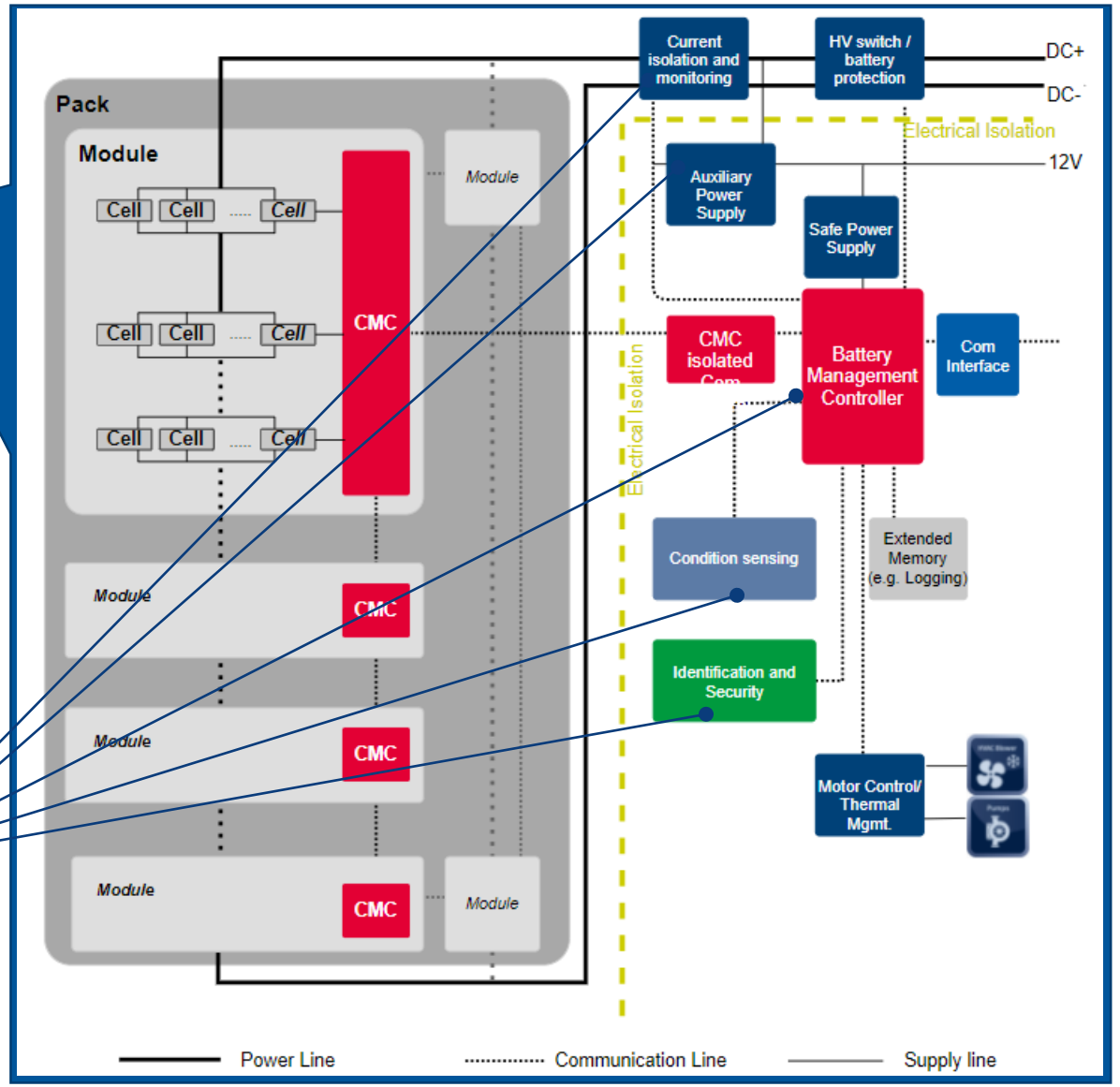
The EBV Application Engineers Approach

System FAEs

- Expertise on system level solutions for specific applications
- Optimize system architecture recommending proven solutions to meet in the shortest time the design requirements at minimum cost
- Technical support for system Integration (interoperability, HW/SW, etc.)

Technology FAEs

- Expertise in specific technologies and product groups
- Deep technical support at device level
- RF, Power, FPGAs, Identification



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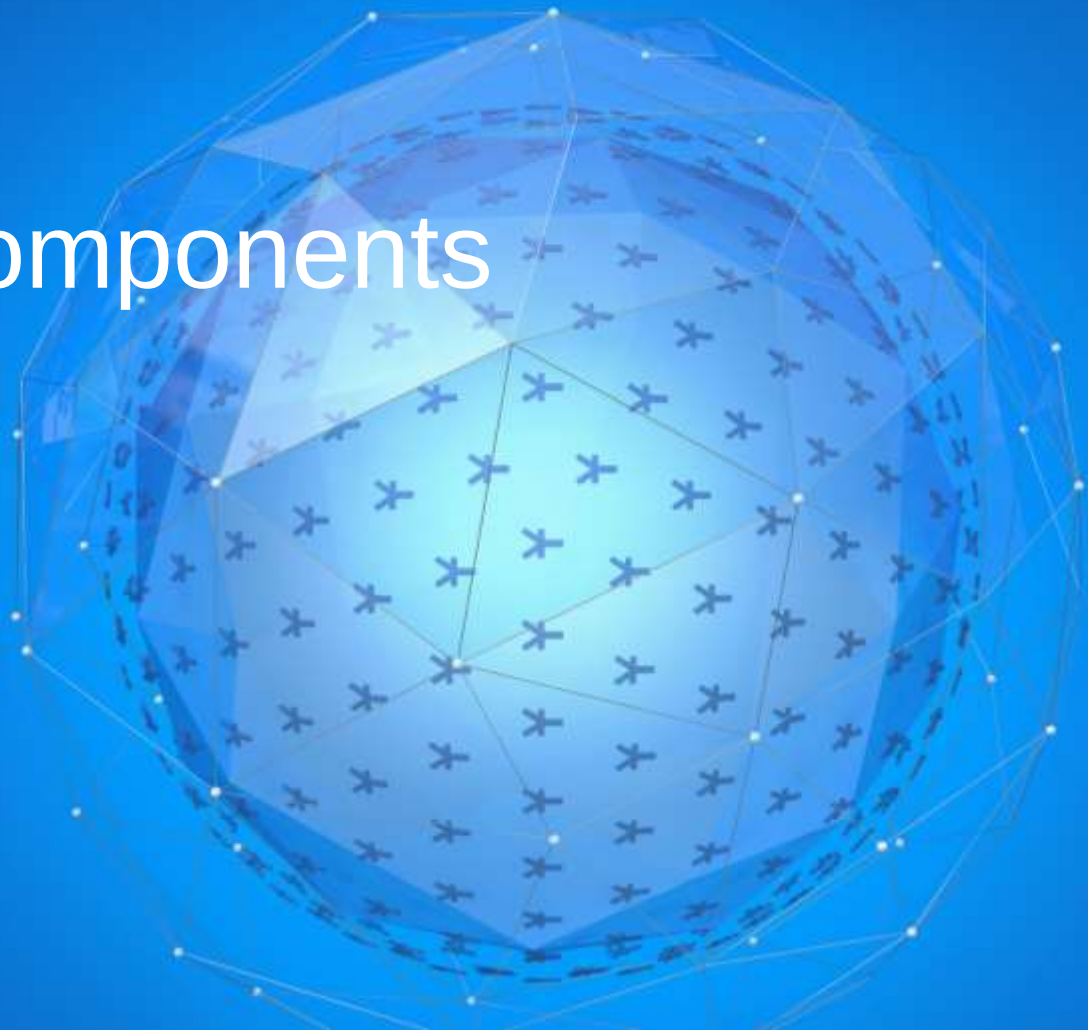
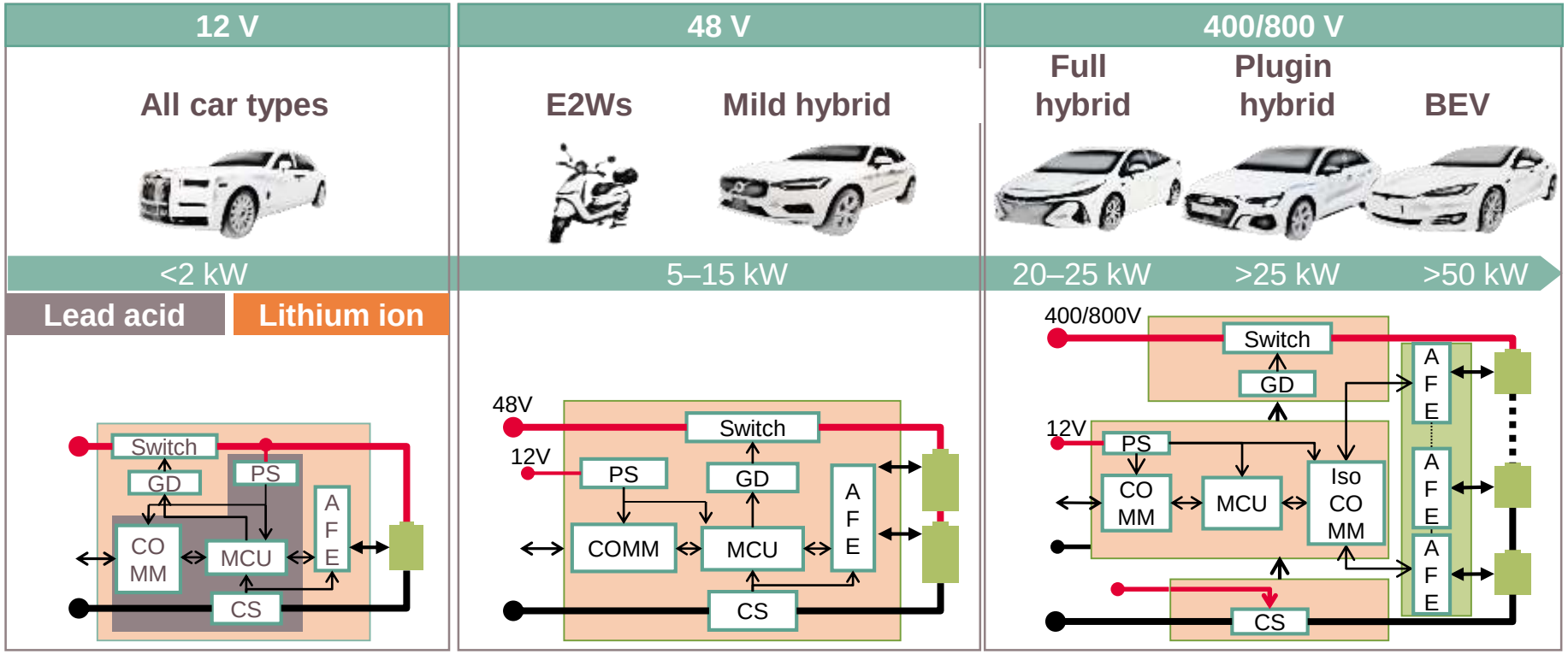
Infineon BMS Hardware Components



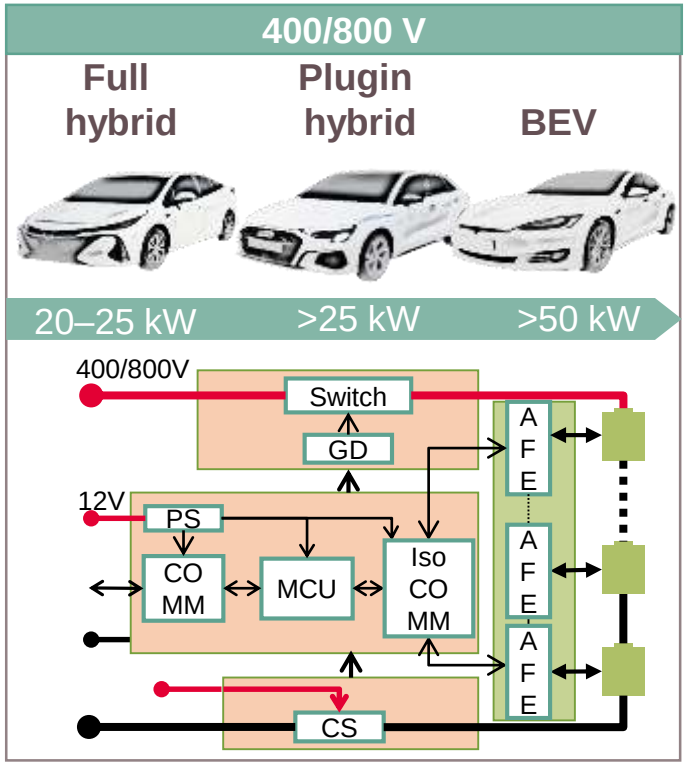
Battery management systems can be distinguished by voltage classes: 12 V, 48 V and 400/800 V

- AFE: analog front end
- COMM: communication (LIN/CAN)
- CS: current sense
- GD: gate driver
- Iso comm: isolated communication
- MCU: microcontroller
- PS: power supply
- Switch: disconnect relay or solid state switch



Infineon offering for HV BMS

		400 V / 800 V	
		Li-ion (BMS) wired	**Li-ion (BMS)** wireless
Integrated solution			
Standalone solution	Wireless transceiver		CYW89829 ES Q4/21
	Current sense	In Development - ES Q2/22	In Development - ES Q2/22
	Monitoring/ balancing IC	TLE9012DQU[D)] PPAP Q4/21	TLE9012DQU[D)] PPAP Q4/21
	Isolated & non-isolated transceiver	TLE9015DQU[D)] PPAP Q4/21 TLE953x	
	PMIC	TLF35584[D)] **available**	TLF35584[D)] **available**
	Host MCU	AURIX™ TC3xx[D)] available	AURIX™ TC3xx[D)] available
	Pressure sensors	KP256[4)i)], KP253[4) i)] available KP236N6165 QM available	KP256[4)i)], KP253[4) i)] available KP236N6165 QM available
	Battery disconnect	CoolMOS™ S7A, PROFET™	CoolMOS™ S7A, PROFET™



B) ASIL B C) ASIL C D) ASIL D i) ISO26262 ready 1) ASIL D under evaluation 2) isoUART compatibility under evaluation 4) ASIL B under evaluation

Infineon BMS Hardware Components

Cell Monitoring & Balancing (CMB) – TLE9012

Battery Communication – TLE9015

Battery Monitoring and Controlling (BMC) – AURIX™ / TRAVEO™ + OPTIREG™

Battery Protection – CoolMOS™ S7A , Barometric pressure sensors

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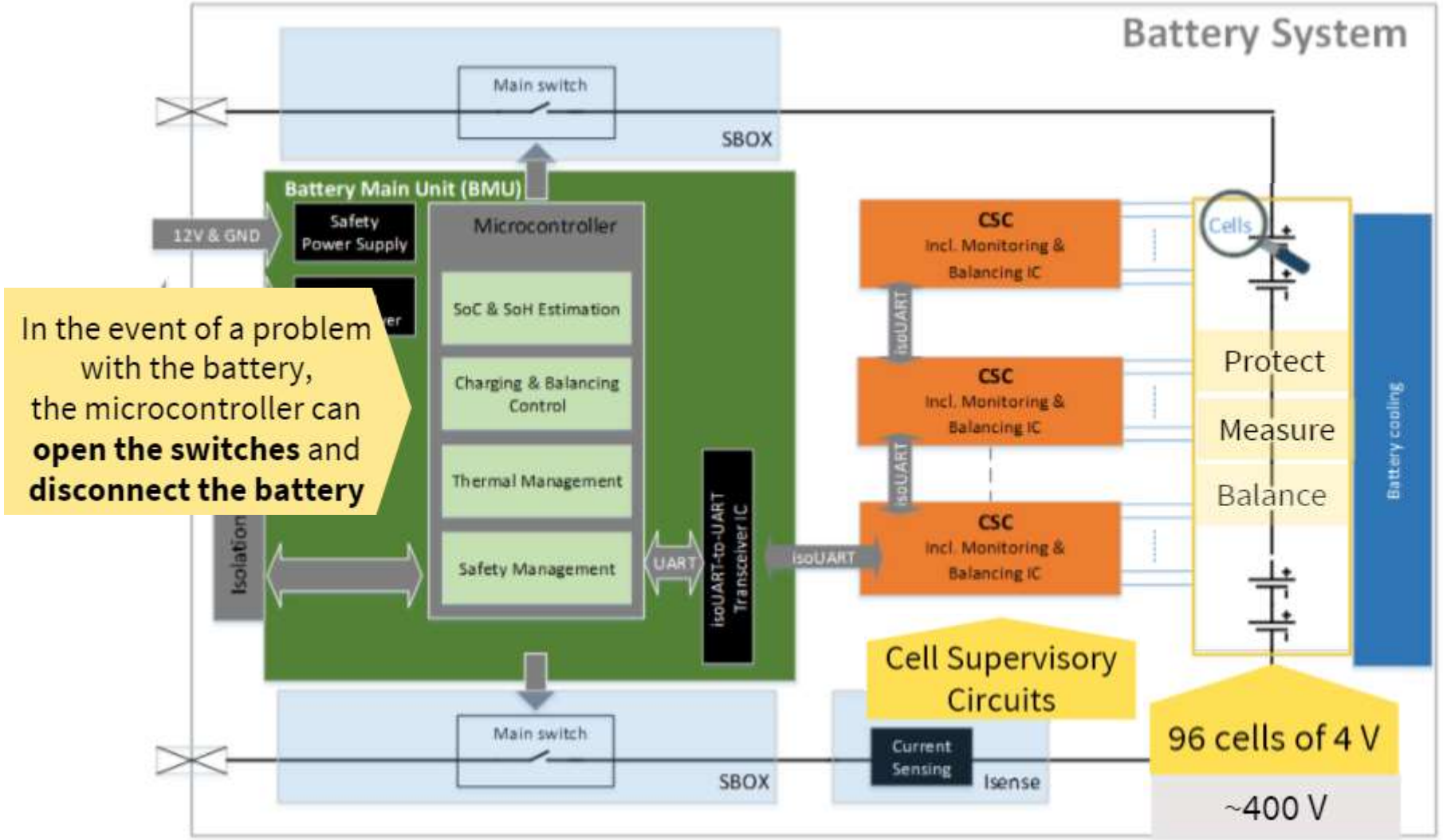
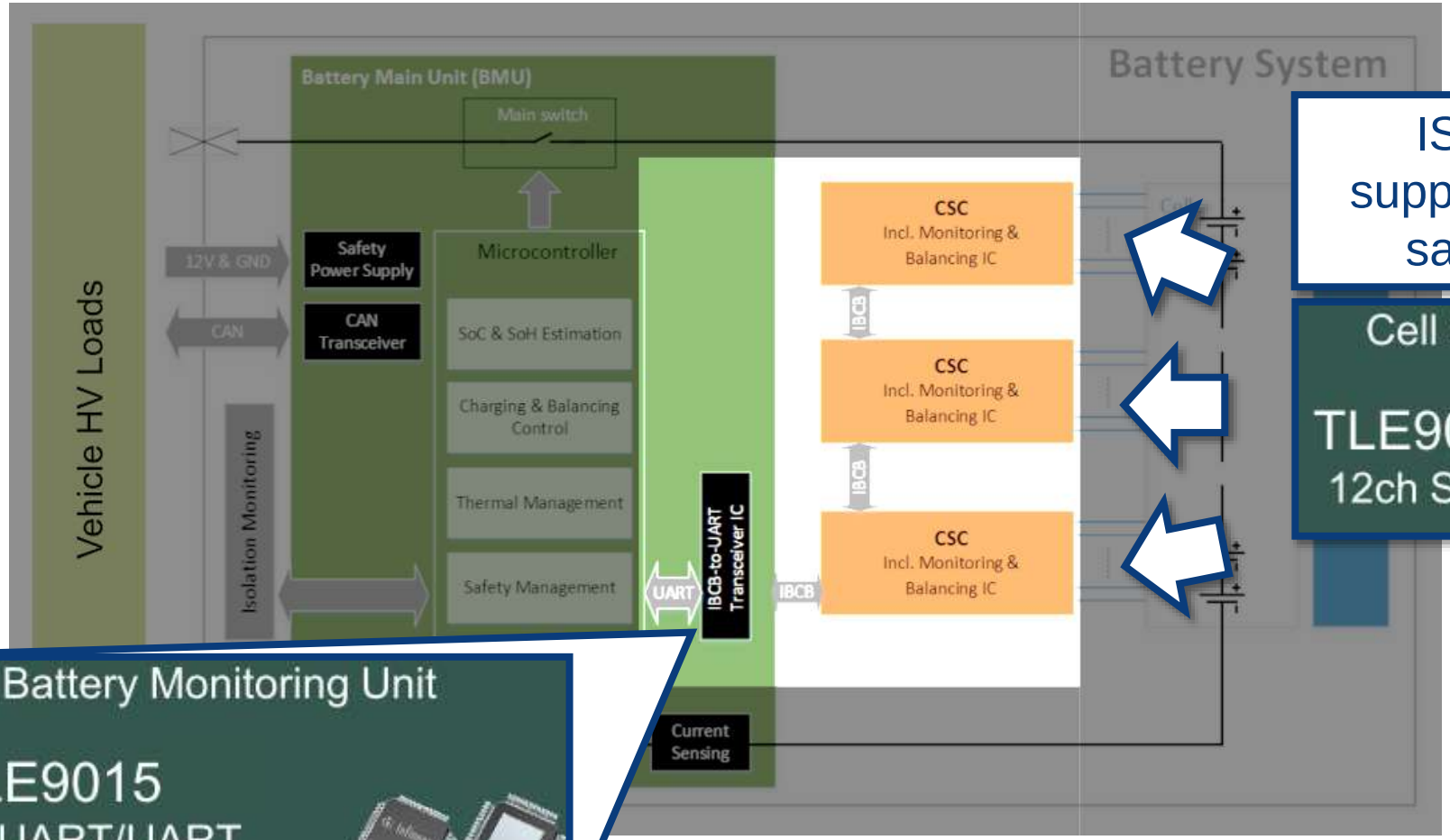
Cell Monitoring & Balancing / Communication

Multi-module batteries – High voltage BMS (400V)



TLE9012 and TLE9015 Battery Management ICs



ISO-26262 ready, supporting ASIL-C BMS safety applications

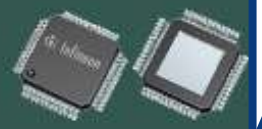
Cell Supervisory Circuit

TLE9012AQU
12ch Sensing IC

The new TLE9012**D**QU (ES available) supports ASIL-D applications

Battery Monitoring Unit

TLE9015
isoUART/UART Transceiver



Ask Your EBV Representative about the available evaluation boards

CSC: Cell-Supervision-Circuit
IBCB: Inter-Block-Communication-Bus = iso UART (iso UART is the new naming)

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TLE9012AQU

Infineon

Sensing and balancing IC

Monitoring functions in CSCs and required for BMS

The EBV Application Engineers ...

Monitors **up to 12 cells** in series

16-bit high resolution **delta-sigma ADC** per cell

70 Hz cut-off

Built-in **digital filter**

5 external **temperature measurement channels**

Synchronized measurements

Min: **4.75 V**

Minimum of **3 cells**

±5.8 mV

Max. accuracy error

Temperature and lifetime **stress compensation**

150 mA/ channel

Integrated **balancing switch**

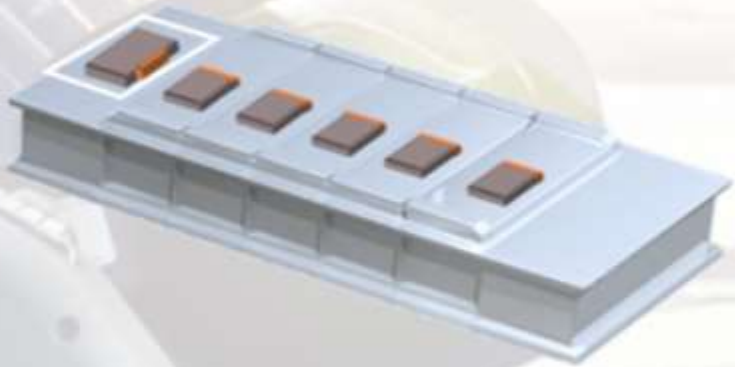
TLE9015DQU a UART to iso UART transceiver IC

Isolated UART transceiver

Supporting device

Communication from **microcontroller** and **TLE9012AQU**

On different grounds



Ring mode topology compatible

1 device

Error management unit

Error output pin

Direct UART communication from **microcontroller** through dedicated **digital pins**

Isolated UART transceiver → fully **transparent communication** to sensing IC

Trigger the **external microcontroller/wake-up signal** from external supply

TLE9012AQU

Accurate voltage measurement

Passive balancing

Temperature measurement

Host communication

Accurate voltage measurement

Accuracy

±5.8 mV end-of-life accuracy

Stress sensor

Advanced temperature compensation

Stress from external sources

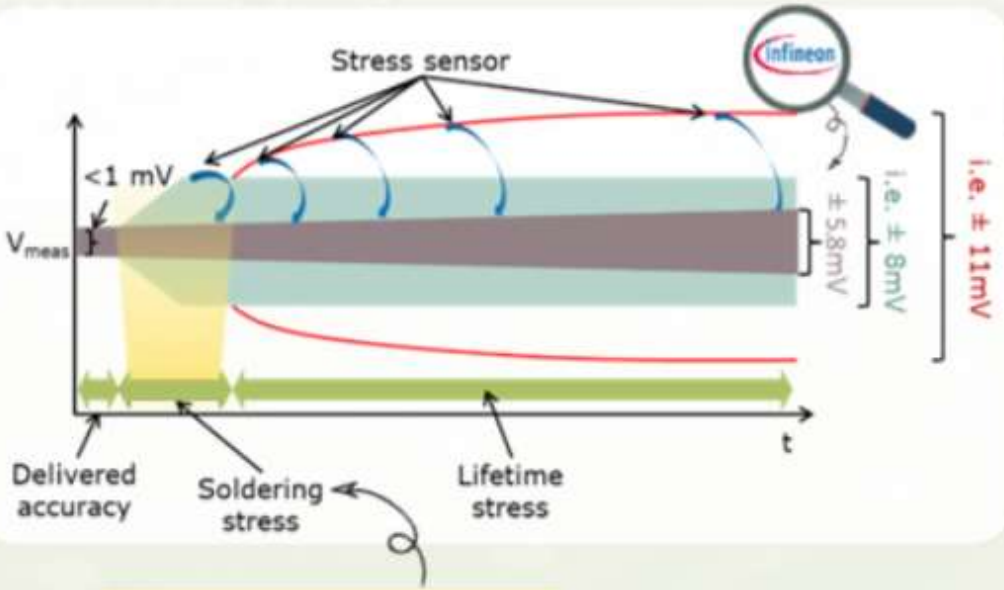
Temperature-related

Mechanical stress

Minimizes effect on accuracy

No end of line calibration needed

Time and cost savings for BMS



Can be compensated

Accurate voltage measurement

Synchronicity

12 delta-sigma ADCs

Voltage of all cells **measured synchronously**

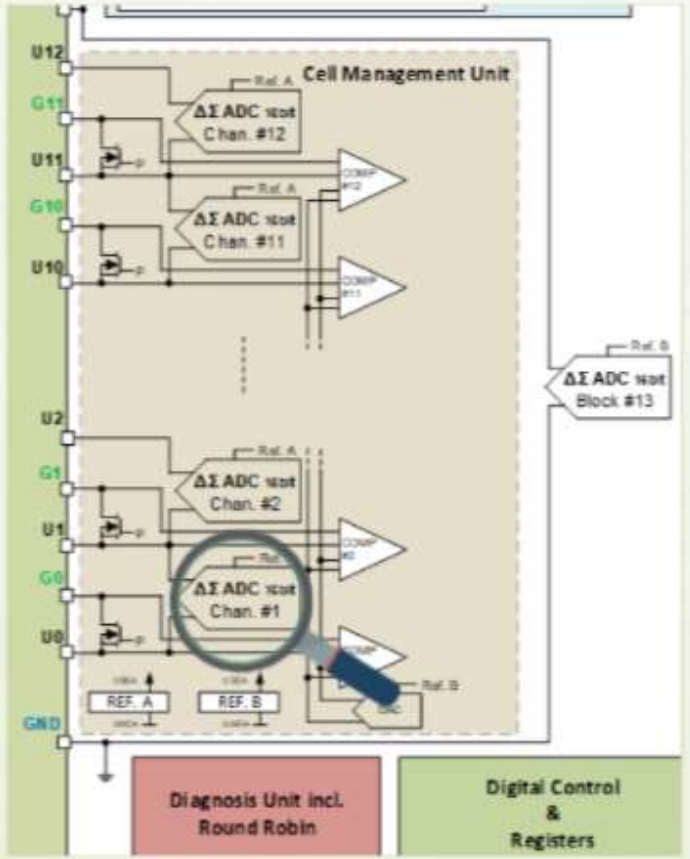
Noises affecting battery

Relative accuracy between cells

ΔΣ ADC

The microcontroller can:

Synchronize with the **current measurement sensing** and calculate **SoC** and **SoH**



Temperature measurement

Automatic measurement

- No triggering from microcontroller
- **Consecutive measurement** on all channels
- **Less traffic** on the **bus**
- If readings are outside the limits, microcontroller can be informed through EMM

Adaptive current selection

- **Negative temperature coefficient** (NTC) current provided and automatically selected by device
- Optimizes the use of the **Full Scale Range** of the **ADC**
- Maximizes **accuracy of temperature measurement** over full range

Host communication

High number of slaves

- Up to **62**
- **No signal loss**

UART communication

- Transferred **UART frames**
- Main communication interface in electronics
- 8-bit **CRC** for **data integrity**

Ring mode topology

- Ensure **fail operational state** if slave or wire fails
- **Availability** of system guaranteed
- **Chain divided** into two

Power-balanced

- Each device needs **same power** to **communicate**
- Achieved in **ring mode** and **single-ended mode**

Passive balancing

Infineon

Balancing diagnosis	Integrated balancing switches	External balancing switches	Balancing time and voltage targets
› **Overcurrent**, **undercurrent** and **open load** detected	› Up to **150 mA** › External resistors → **reduce chip power consumption**	› Support PMOS switches for **increased current balancing** › When 150 mA from integrated switches are **not enough**	› Programmed to **stop after given time** (up to 32 hours) › **No interaction** from microcontroller needed

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Power Supply for Battery Main Unit

OPTIREG™ PMIC :
The #1 power supply solution for AURIX™ microcontroller family

OPTIREG™ PMIC : THE AURIX™ supply

- #1 Functional Safety supply for AURIX™
- >20Mpcs already shipped worldwide
- >300 projects secured at all major OEMs
- >30 different applications
  (xEV, Chassis, Safety, ADAS, Body)

General Purpose AURIX™ TC2x/3x PMICs

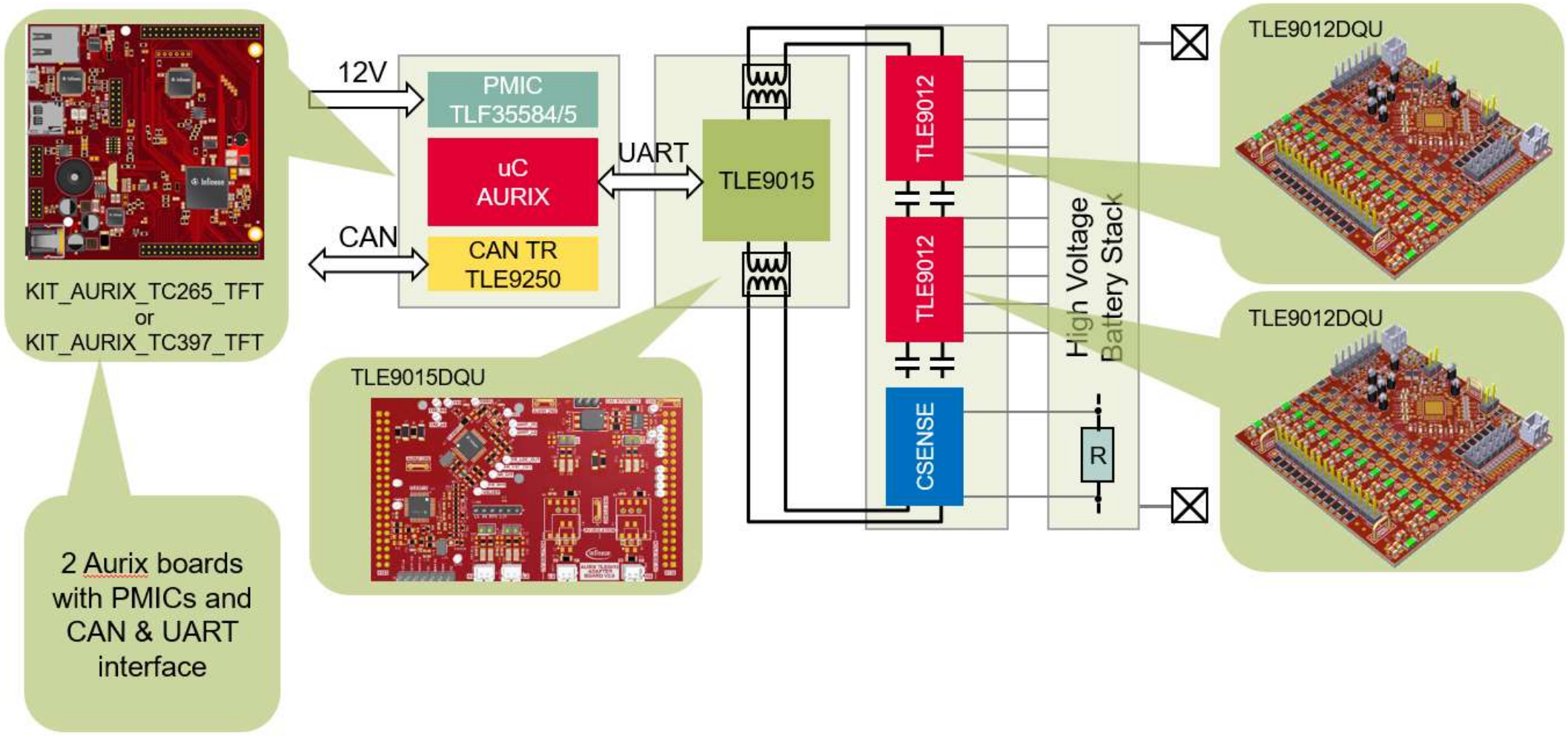
ISO26262 compliant

TLF35584 & TLF35585

In Production/ In Development

- Scalable general purpose PMIC for AURIX™ TC2x/3x
- ISO26262 compliant, supporting ASIL D classified automotive systems
- Extended performance by using TLF11251, improving supply efficiency by up to 25%

Fast and easy evaluation of HV BMS with evaluation kits



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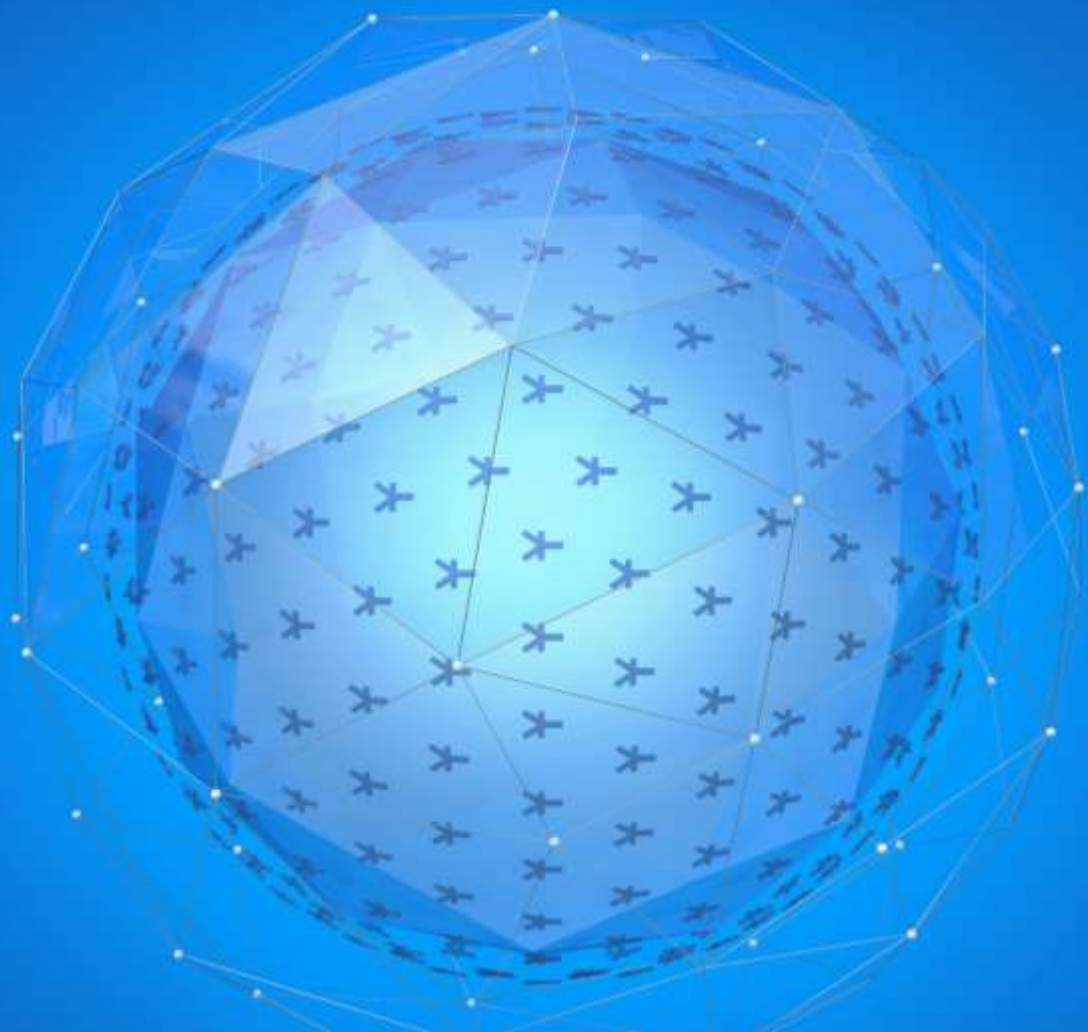
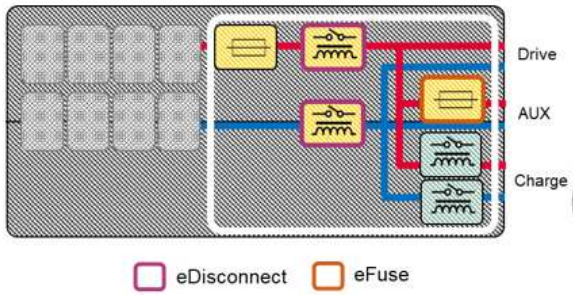
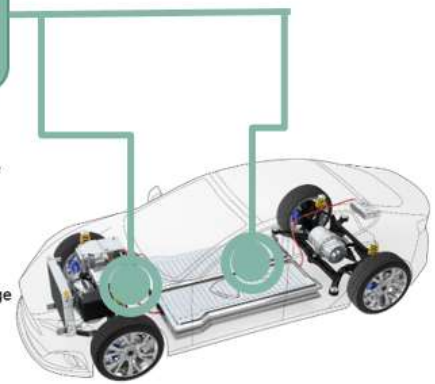
Battery Protection

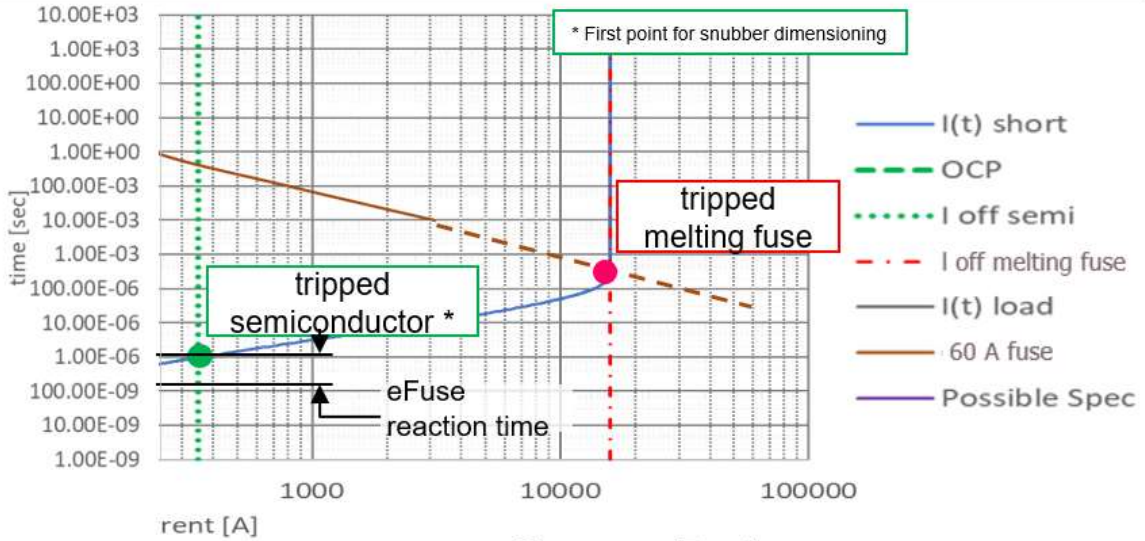


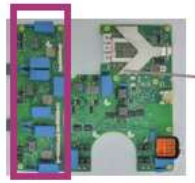
eFuse have faster response and longer lifetime that mechanical switches

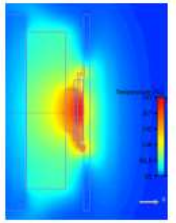
HV eFuse and HV eDisconnect switch







Application	State of the art		Success Factors
Central eFuse for auxiliaries		**Main difficulties:** › Space, weight, reliability, mechanical vibrations › Maintenance costs, accessibility › Reaction time	› *CoolMOS™ S7A* › QDPAK TSC › Best-in-class R_{on} x A x cost › Lowest R_{on} in a SMD package
Main relay or pyro-fuse replacement		**Main difficulties:** › Fuse box inside sealed battery › Fuse aging › High costs in case of repair	› *Customer support* › Thermal simulations › Circuit design



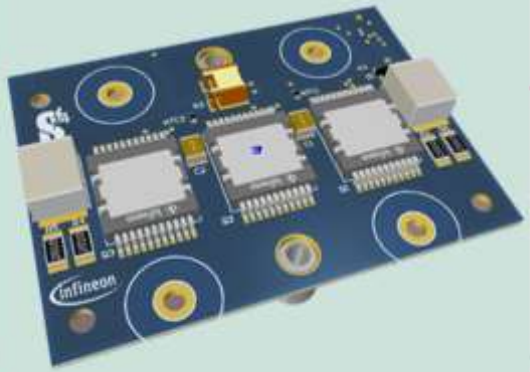
CoolMOS™ S7A for HV eFuse – the semiconductor path with a safer, more reliable and controllable solution

Applicable to 400 V & 800 V vehicle network
- Scalable to different current classes
- OBD capability

Same constructed space as melting fuse
- Maintenance free
- No accessibility required
- No openings for maintenance needed

Functional Safety according to ASIL-C
- Integrated current and temperature measurement
- Enables high availability supply with state-of-health indication and pre-warning.

HV eFuse System-Demonstrator

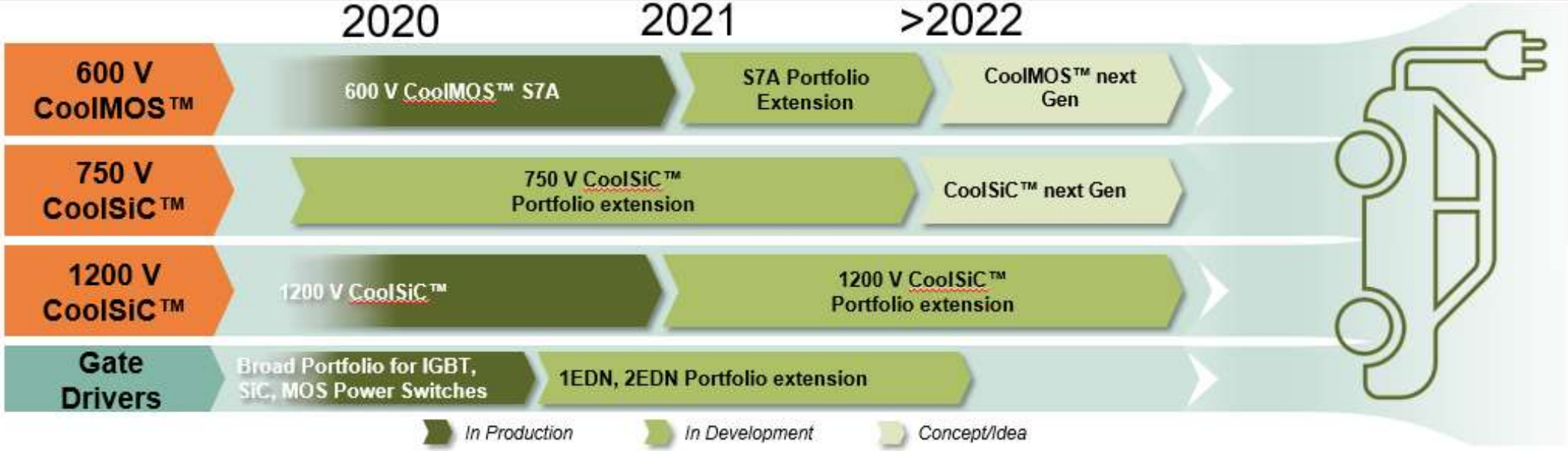


Cost optimized system solution
- Can be integrated into available system components
- Dedicated chip set
- No current stress integral degradation

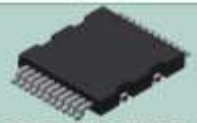
Selective, arcing-free switch-off in case of failure
- Minimized failure propagation into vehicle network
- Reset possible via OBD command

Flexible system integration
- Variable cooling strategy
- Scalable technology

A wide roadmap dedicated for HV power switch technologies



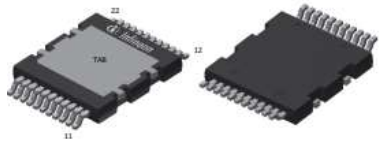
AEC Qualified

$R_{DS(on,max)}$ [mΩ]	 PG-TO247-3	 QDPAK TSC PG-HDSOP-22-1	 QDPAK BSC PG-HDSOP-22-101
40	IPW60R040S7A**	IPDQ60R040S7A**	IPQC60R040S7A**
22	IPW60R022S7A**	IPDQ60R022S7A**	IPQC60R022S7A**
17	IPW60R017S7A**	IPDQ60R017S7A**	IPQC60R017S7A**
10	IPW60R010S7A**	IPDQ60R010S7A*	IPQC60R010S7A**

*Released
**Coming soon

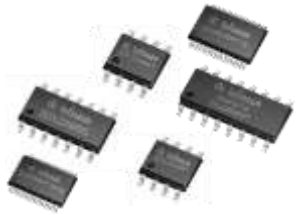
eFuse & eDisconnect

power	*driving*	*sensing*	*control*
CoolMOS™ S7A	***EiceDRIVER™***	***XENSIV™***	***AURIX™***



- 10mΩ BiC
- 800A pulse current
- High power SMD
- Kelvin Source

600V-800V N-Channel Automotive MOSFET - Infineon Technologies



- Safe operation
- High efficiency
- Lower system size & weight

Gate Driver ICs - Infineon Technologies

- Magnetic sensing solution with ultra-low insertion resistance
- Galvanic insulation
- Analog measurement w/ high speed overcurrent detection

Sensor Technology - Infineon Technologies

- Scalable
- Safe/ secure
- Broad connectivity

32-bit Microcontroller (MCU) - Infineon Technologies

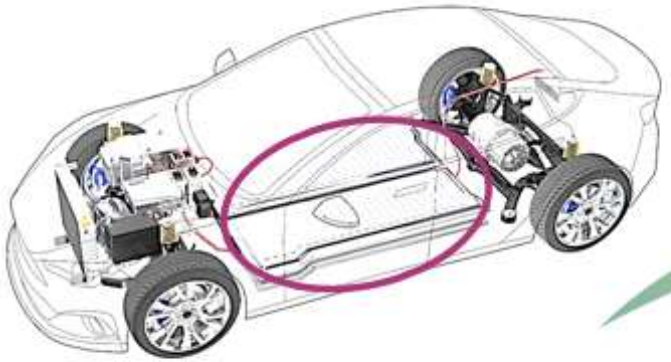
We have a broad and high quality product spectrum to enable eFuse & eDisconnect

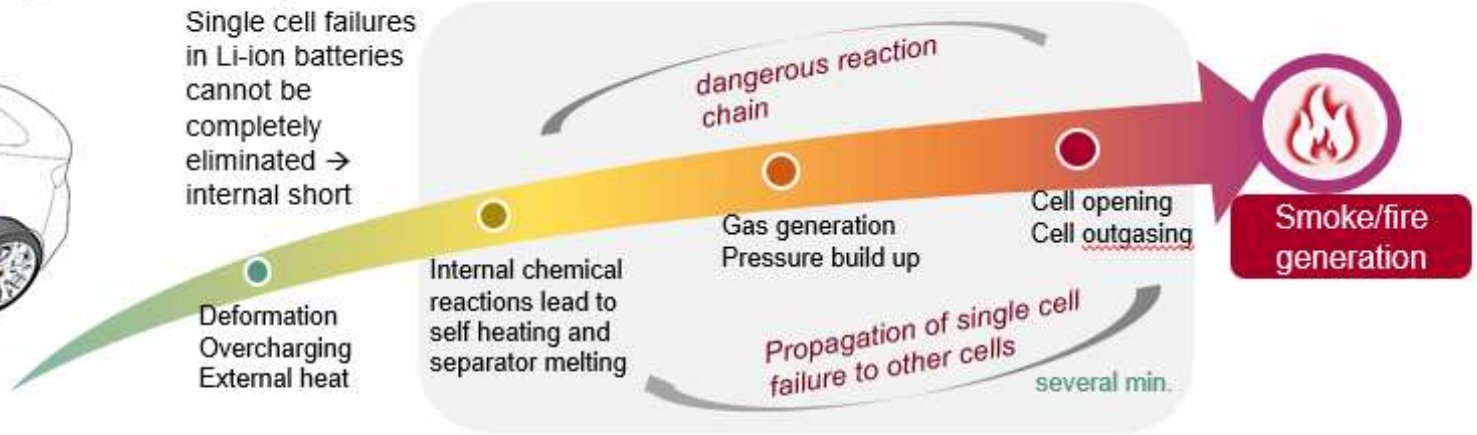
Thermal runaway (TR) a growing concern around safety of electric vehicles

infineon

Thermal Runaway challenge

- prevent TR or give passengers enough time to safely leave their car





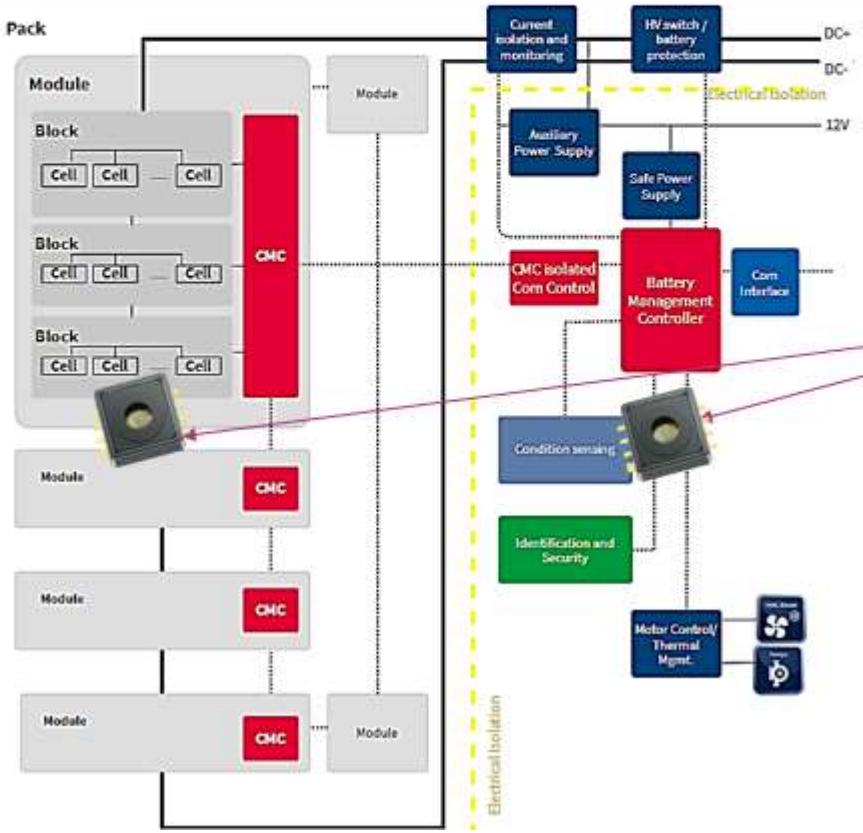
3 level strategy of reducing hazards caused by TR

Challenge	Description	Solution
Very Early Warning	Mechanical, electrical, thermal abuse start internal chemical reactions	warn the passenger of the coming fault: CO_2 sensor for overcharging detection? Crash detection sensor?
Intrinsic Safety	Avoid TR and/or Propagation	improve material properties at cell and pack level
Extend Time for Escaping	Propagation of TR cannot be stopped	**Pressure sensor for accurate, fast and reliable detection of thermal runaway**

Pressure sensor reliably detects beginning thermal runaway independent of position inside battery pack

GTR20 Thermal Propagation Regulation: The vehicle shall provide an advance warning indication to allow egress or 5 minutes prior to the presence of a hazardous situation inside the passenger compartment caused by thermal propagation which is triggered by an internal short circuit leading to a single cell thermal runaway such as fire, explosion or smoke.

UNITED NATIONS

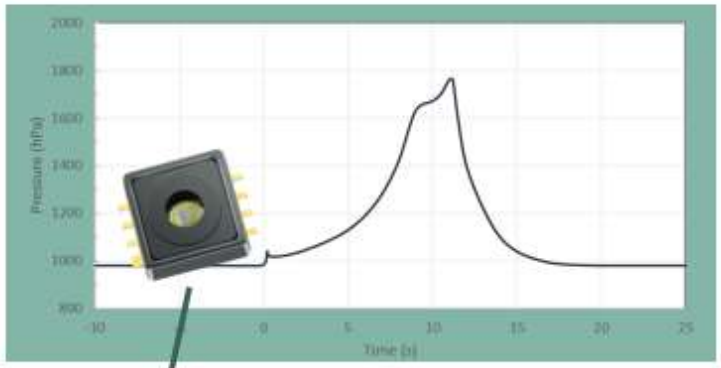


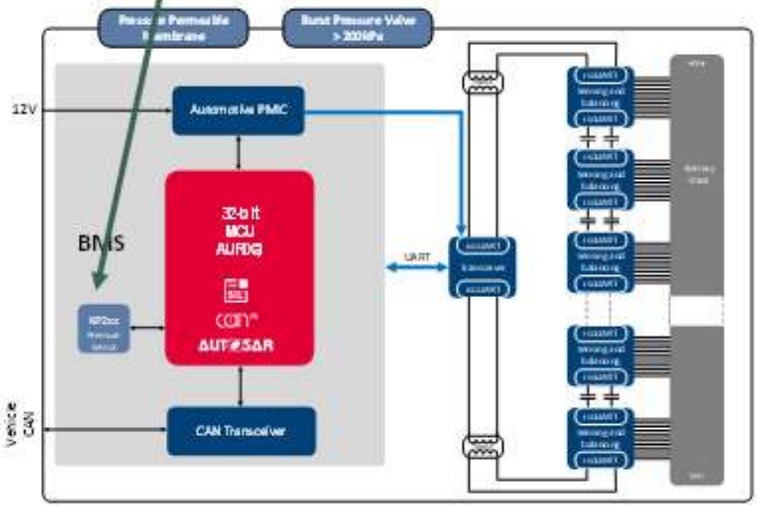
Barometric Pressure Sensor for Thermal Runaway detection can be placed inside battery pack housing or inside central control box (BMS)

➔ Pressure sensor triggers a warning signal for the driver/passengers to meet requirements of GTR20

➔ Pressure sensor detects a cell opening very reliable and avoids any false alarm

Absolute Pressure Measurement within Battery Pack





Two options for pressure increase detection with the absolute pressure sensor

Option 1

ECU pressure sensor (BAP)

$\Delta p = p2 - p1$

Option 2

$p = p2 \rightarrow p1$

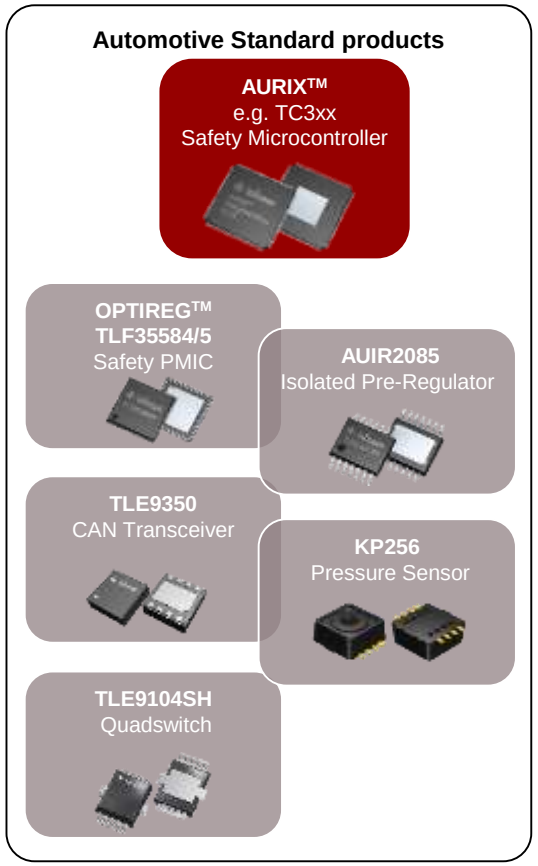
$\Delta p = p2 - p1$

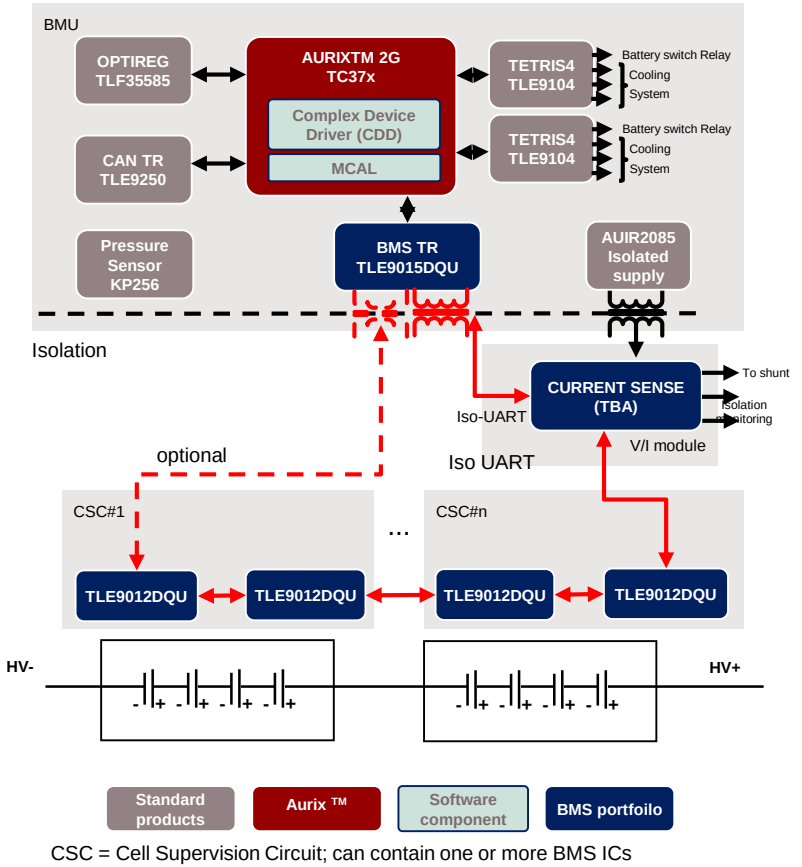
Overview of the pressure sensors for BMS application

	60 kPa	165 kPa
Analog	KP236N6165	-40 ➔ 125°C, 0.2 ➔ 4.8 V
Analog	KP253	-40 ➔ 125°C, 12 bit
Analog	KP256	-40 ➔ 125°C, 10 bit
Digital	KP466*	-40 ➔ 125°C, 10/12/14 bit

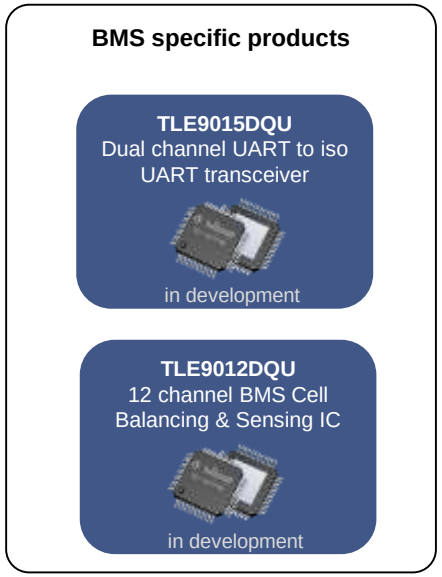
* In development

Infineon one stop shop for HV BMS products





CSC = Cell Supervision Circuit; can contain one or more BMS ICs



Contact EBV for samples, pricing, evaluation tools and hardware design support

In summary

EBV Elektronik is Infineon no.1 distribution partner in EMEA
with Technical expertise from System level to Device level
from Digital to Analog and Power
to support your next design from Idea to Production.

Get in touch with us!

EBV Elektronik locations and contacts

Thank you for your attention!