



AURIX Knowledge Lab 2021

Battery management in control!

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Battery management in control!



TASKING[®]

escrypt
SECURITY. TRUST. SUCCESS.



hitex 
EMBEDDED TOOLS & SOLUTIONS

Agenda

1. AURIX Project Basics

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. AURIX Safety and Security

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. Software Quality and Test

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. PDH, eval boards, trainings and summary of event

4.1

« Why work with a Preferred Design House for safety and security »

Hitex



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EBV + Infineon



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

**EBV'S RANKING
WITHIN THE DISTRIBUTION NETWORKS
OF THESE SUPPLIERS**

NO. 1

EBV'S RANKING WITHIN THE DISTRIBUTION NETWORKS OF THESE SUPPLIERS



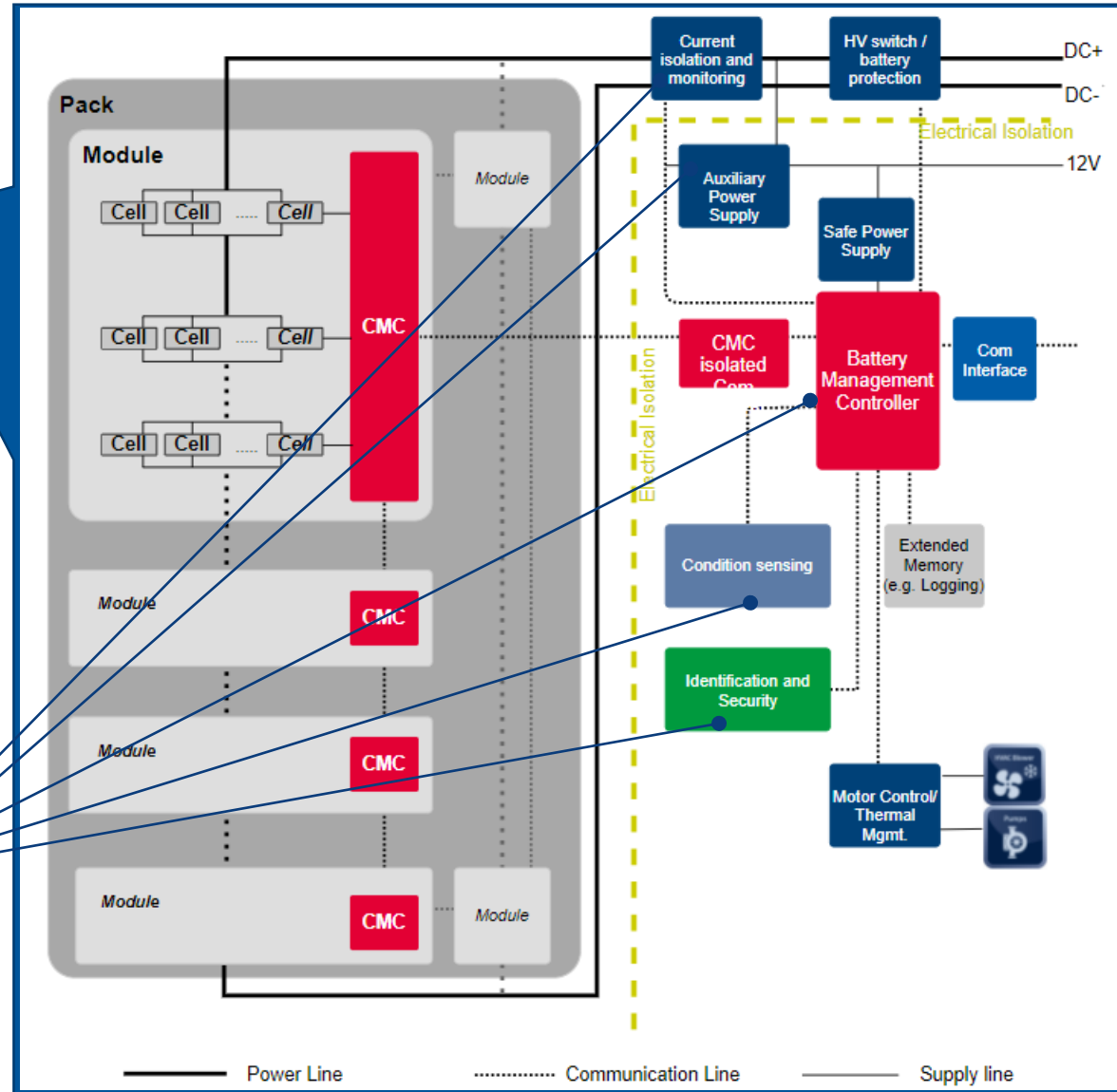
The EBV Application Engineers Approach

System FAEs

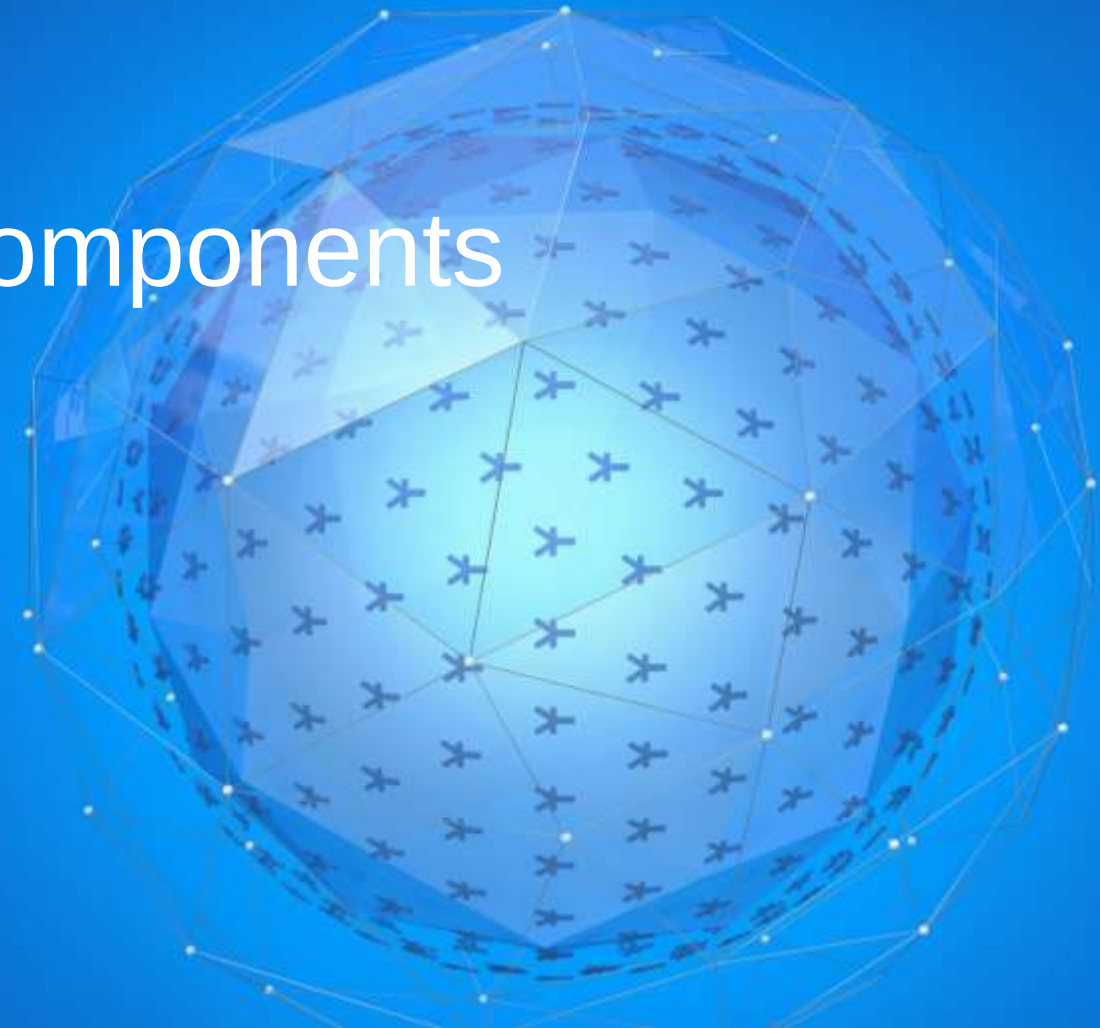
- Expertise on system level solutions for specific applications
- Optimize system architecture recommending proven solutions to meet in the shortest time the design requirements at minimum cost
- Technical support for system Integration (interoperability, HW/SW, etc.)

Technology FAEs

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

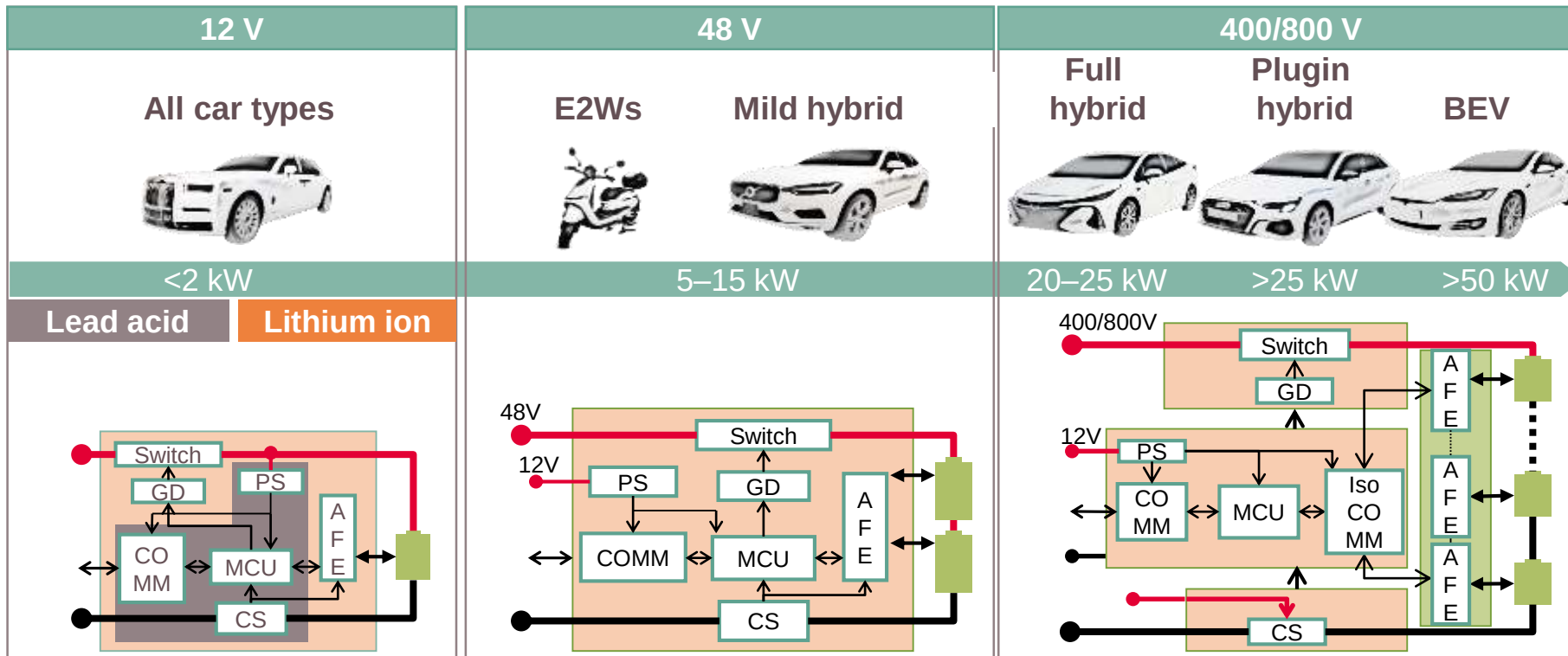


Infineon BMS Hardware Components



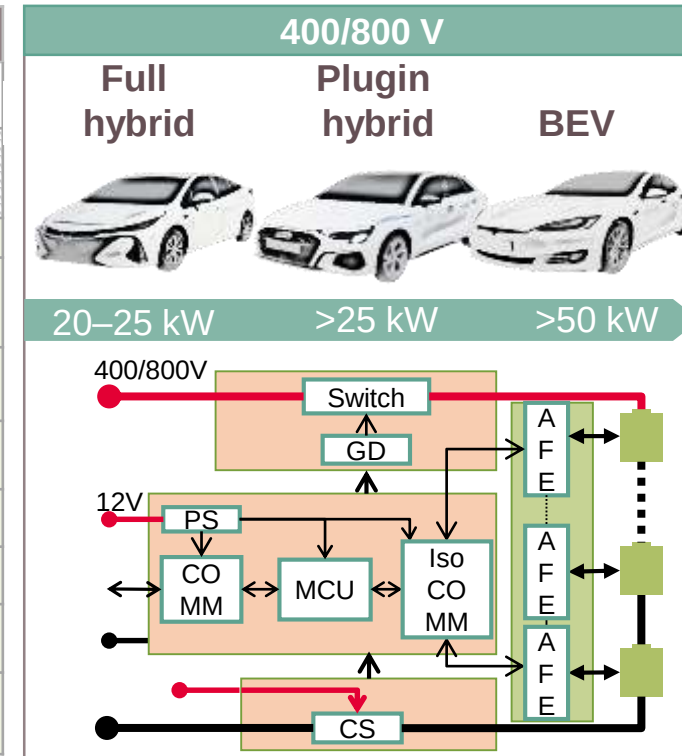
Battery management systems can be distinguished by voltage classes: 12 V, 48 V and 400/800 V

- › AFE: analog front end
- › CS: current sense
- › Iso comm: isolated communication
- › PS: power supply
- › COMM: communication (LIN/CAN)
- › GD: gate driver
- › MCU: microcontroller
- › 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™



Infineon BMS Hardware Components

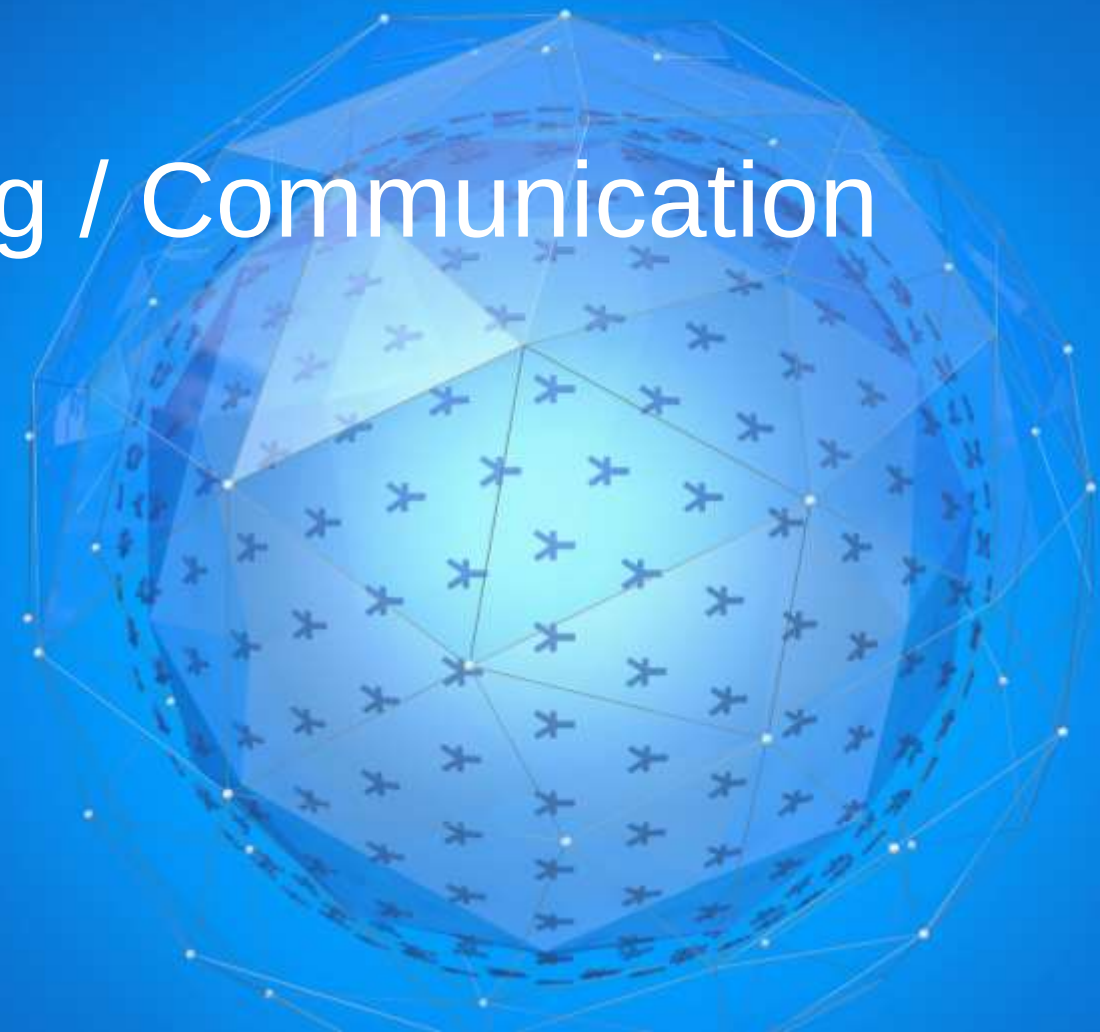
Cell Monitoring & Balancing (CMB) – **TLE9012**

Battery Communication – **TLE9015**

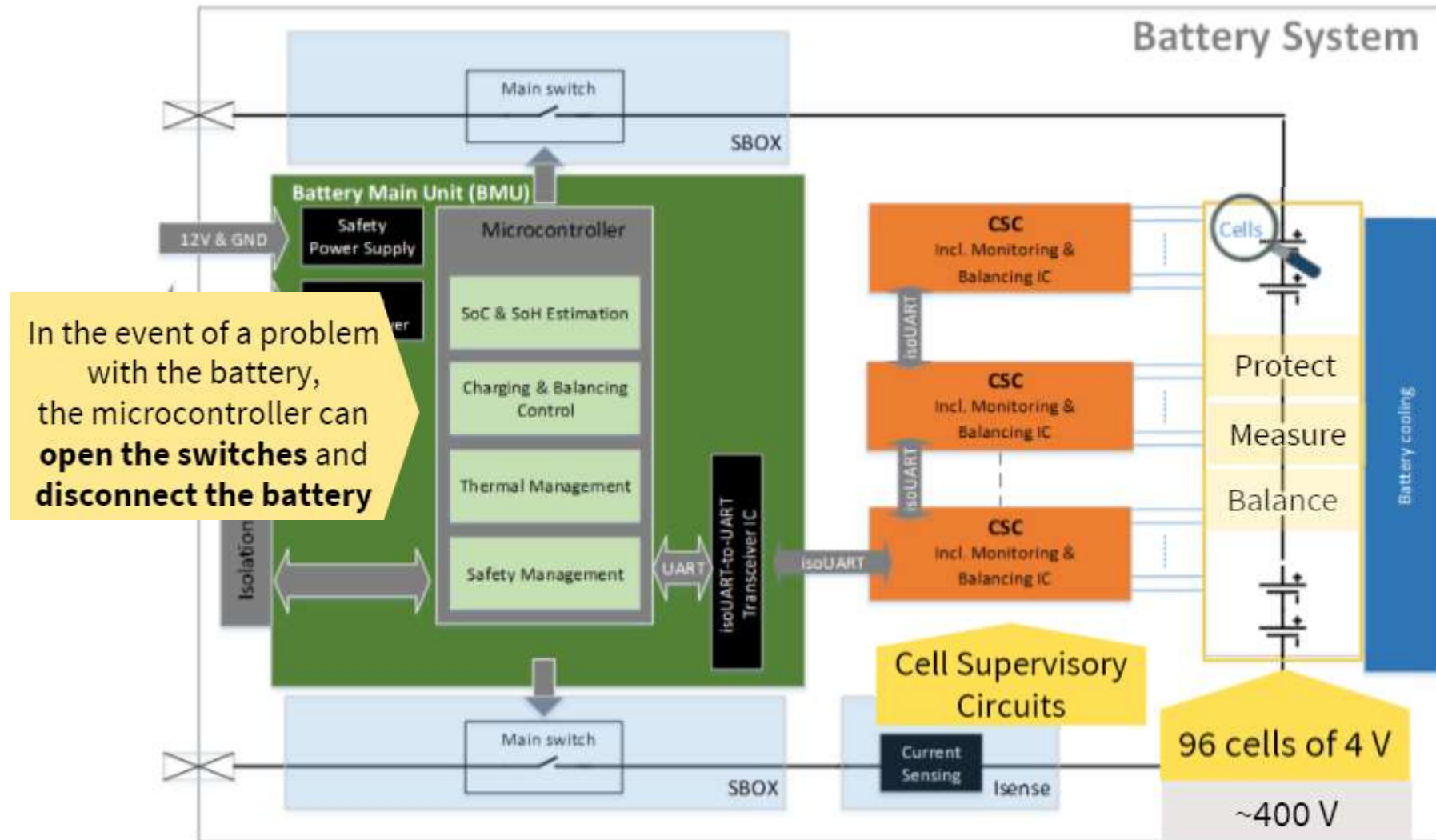
Battery Monitoring and Controlling (BMC) – **AURIX™ / TRAVEO™ + OPTIREG™**

Battery Protection – **CoolMOS™ S7A** , Barometric **pressure sensors**

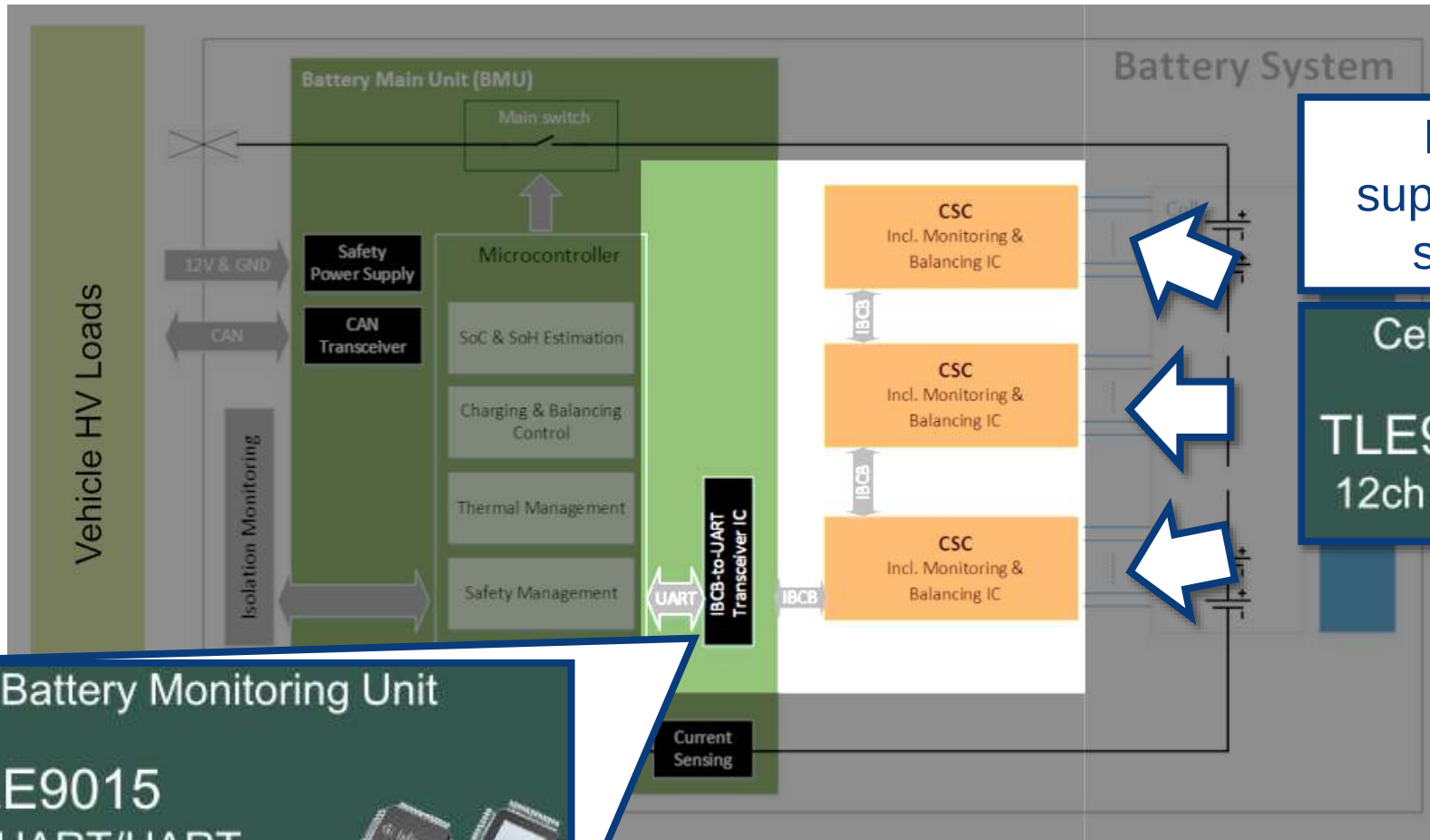
Cell Monitoring & Balancing / Communication



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
TLE9012DQU
(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)

TLE9012AQU

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

Synchronized measurements

Minimum of **3 cells**

Min:
4.75 V

±5.8 mV

Max. accuracy error

Temperature and
lifetime **stress compensation**

70 Hz
cut-off

Built-in
digital filter

5 external
temperature measurement channels

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

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

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

Ring mode
topology compatible

1
device



Error
management
unit

Error output
pin

**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



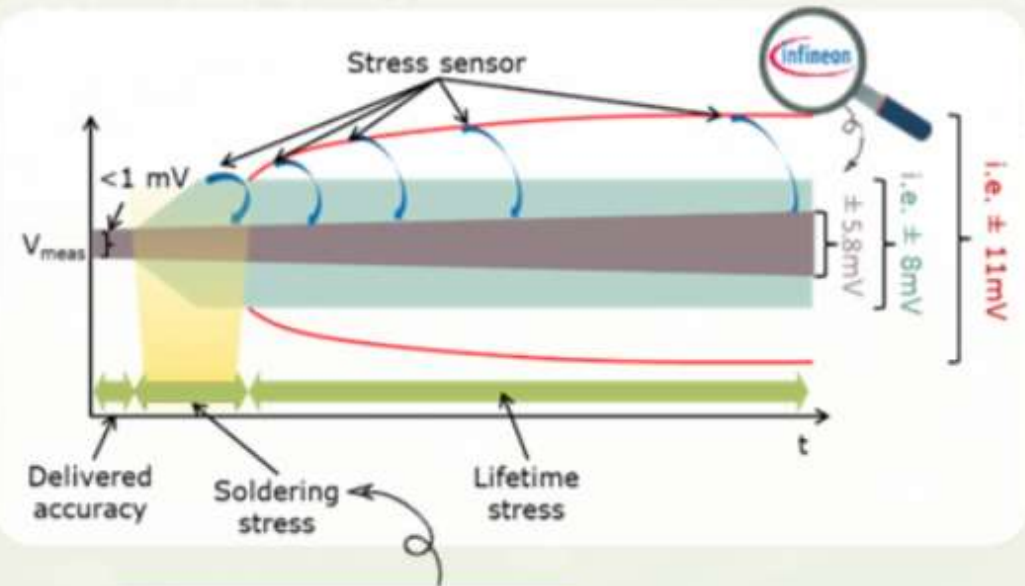
Mechanical stress

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**

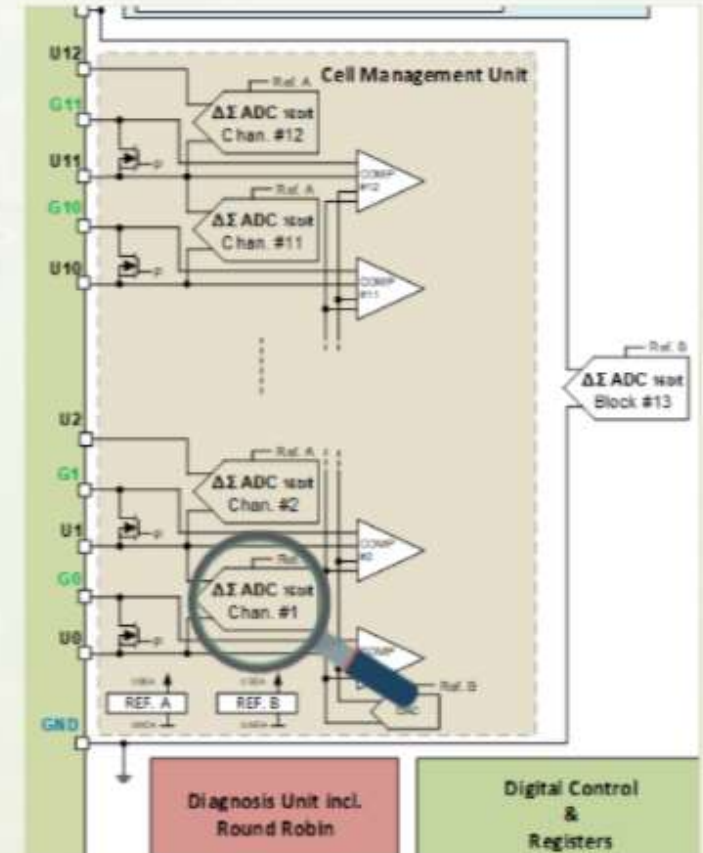
Noises affecting
battery

Relative accuracy
between cells

$\Delta\Sigma$
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



Balancing diagnosis

- › **Overcurrent, undercurrent and open load** detected

Integrated balancing switches

- › Up to **150 mA**
- › External resistors → **reduce chip power consumption**

External balancing switches

- › Support PMOS switches for **increased current balancing**
- › When 150 mA from integrated switches are **not enough**

Balancing time and voltage targets

- › Programmed to **stop after given time** (up to 32 hours)
- › **No interaction** from microcontroller needed

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

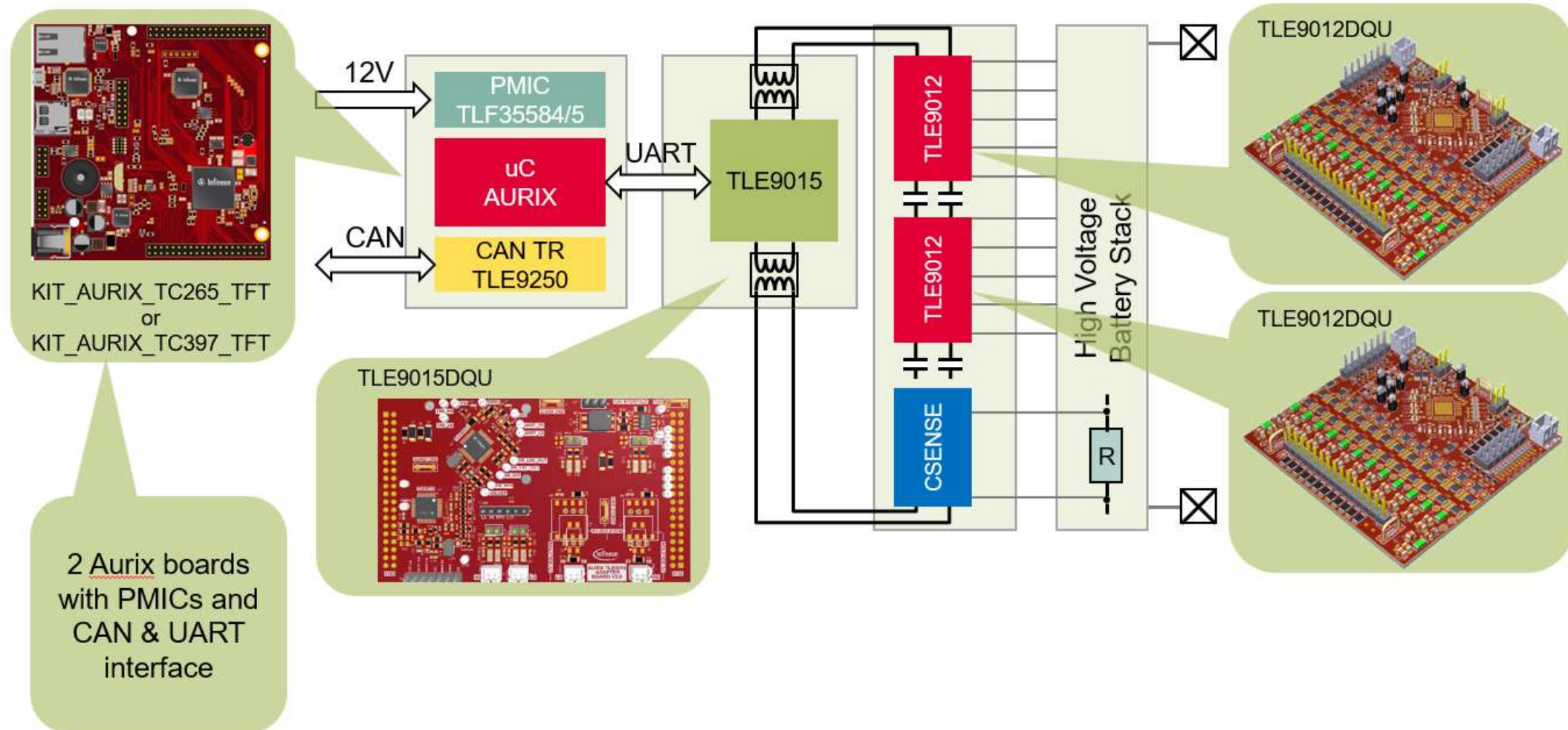


TLF35584 & TLF35585

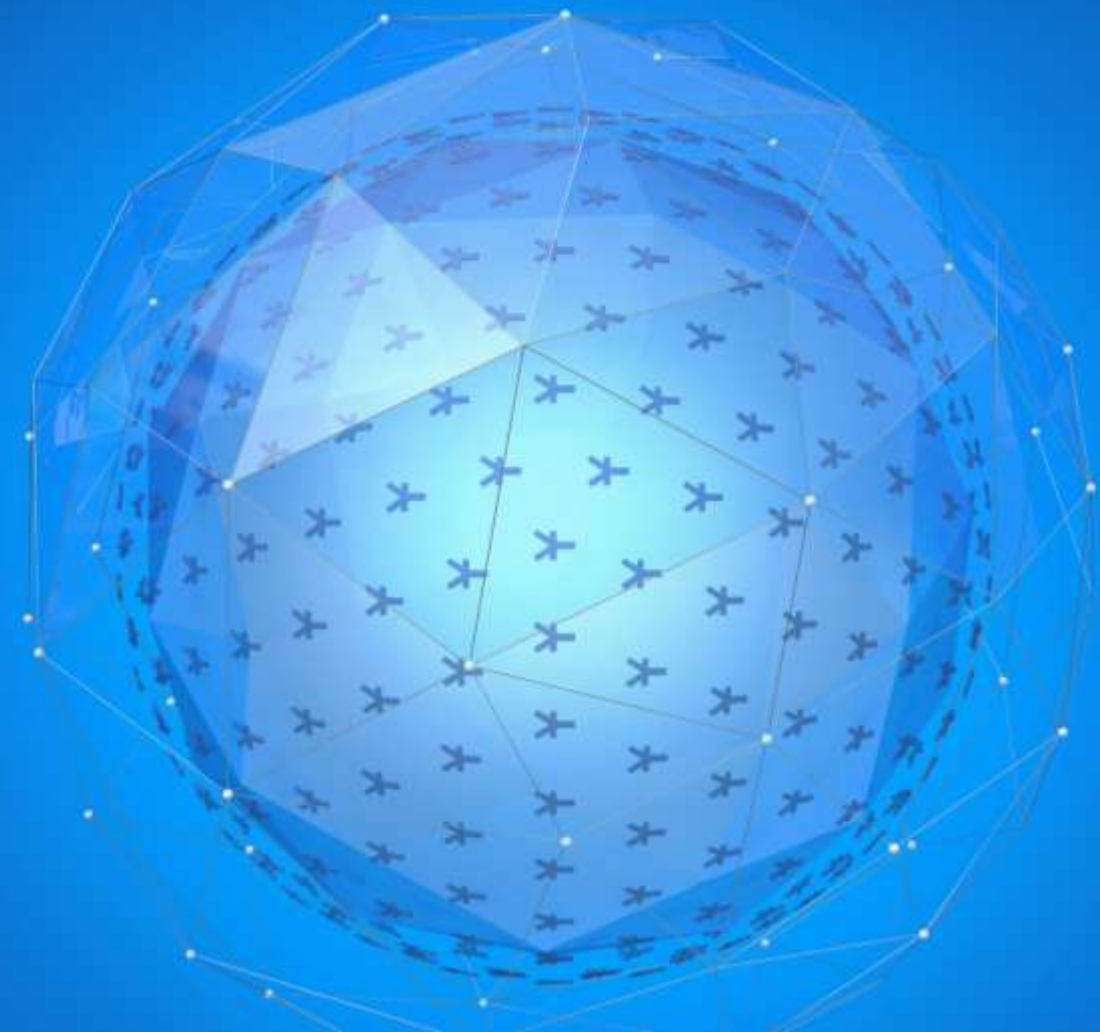
In Production/
In Development

- › 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%

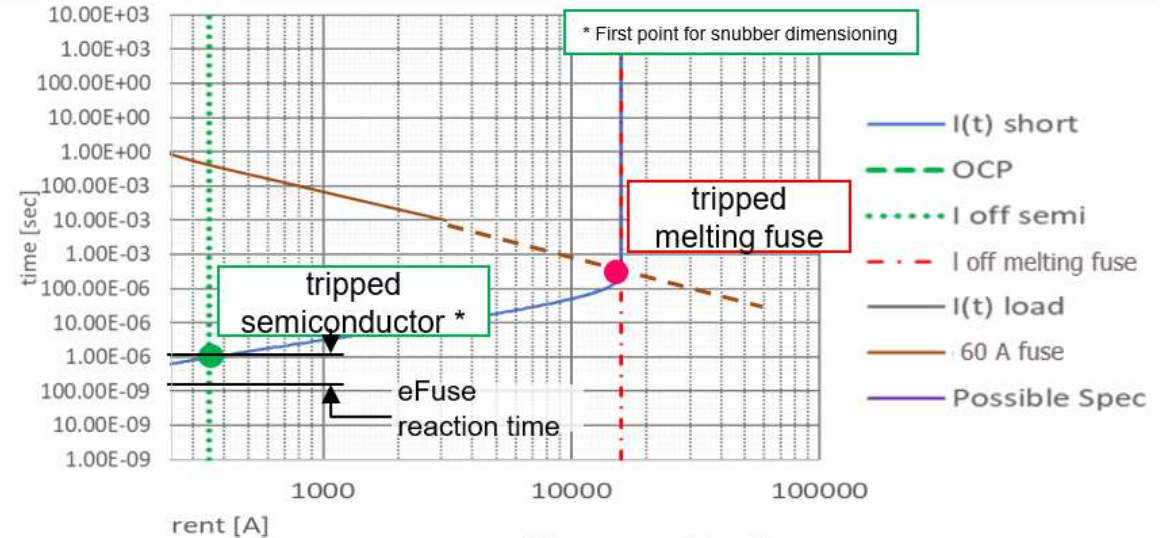
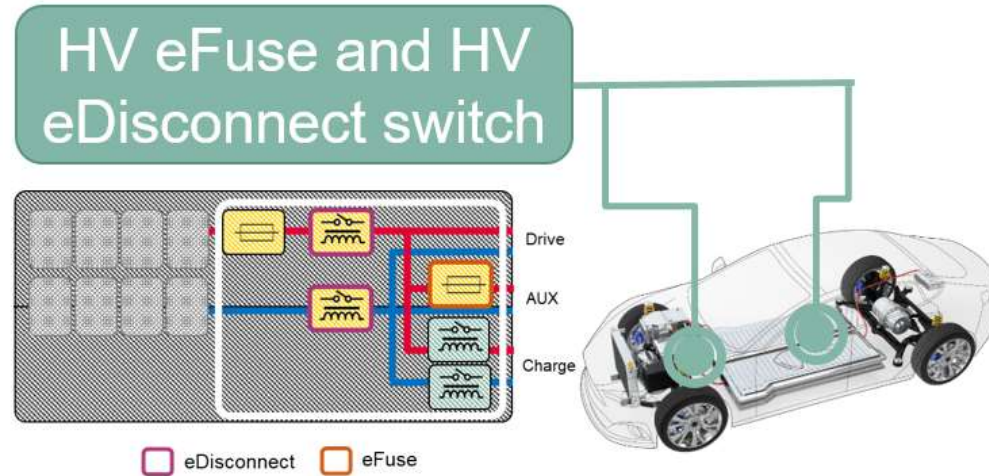
Fast and easy evaluation of HV BMS with evaluation kits



Battery Protection



eFuse have faster response and longer lifetime than mechanical switches



Application State of the art

Central eFuse for auxiliaries



Main difficulties:

- › Space, weight, reliability, mechanical vibrations
- › Maintenance costs, accessibility
- › Reaction time

Main relay or pyro-fuse replacement

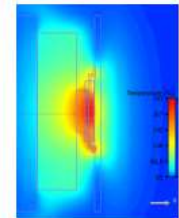


Main difficulties:

- › Fuse box inside sealed battery
- › Fuse aging
- › High costs in case of repair

Success Factors

- › CoolMOS™ S7A
 - › QDPAK TSC
 - › Best-in-class R_{on} x A x cost
 - › Lowest R_{on} in a SMD package
- › 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

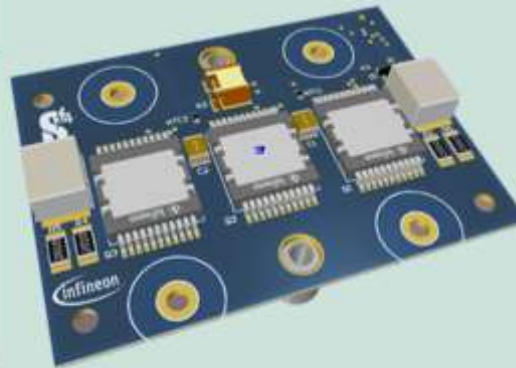
Same constructed space as melting fuse

- › 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

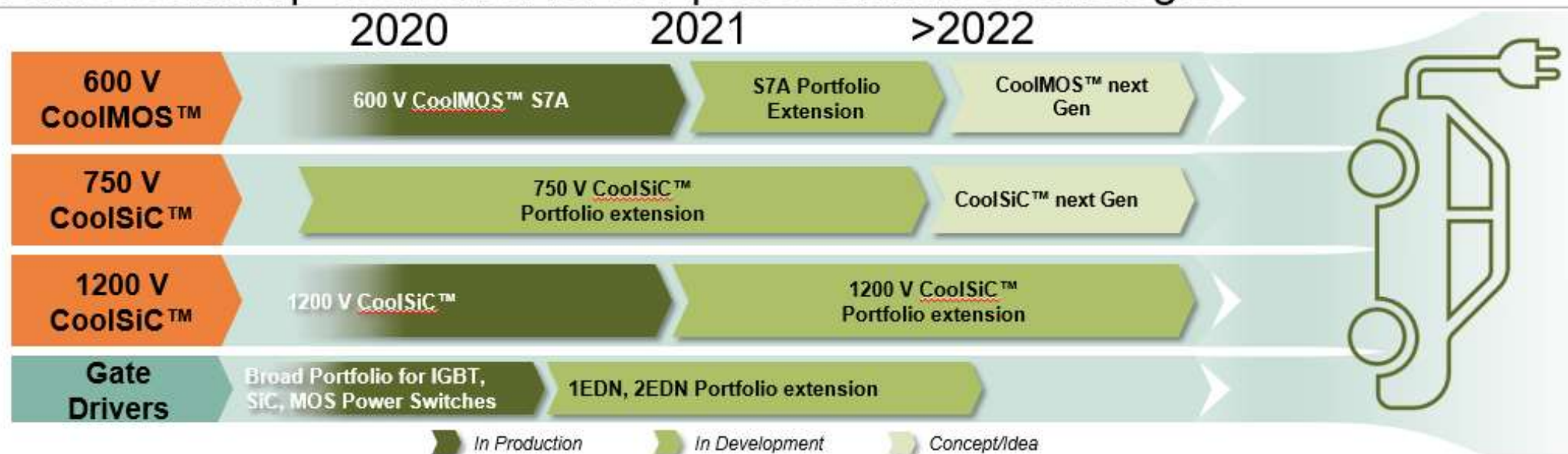
Selective, arcing-free switch-off in case of failure

- › Minimized failure propagation into vehicle network
- › Reset possible via OBD command

Flexible system integration

- › Variable cooling strategy
- › Scalable technology

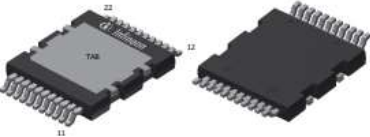
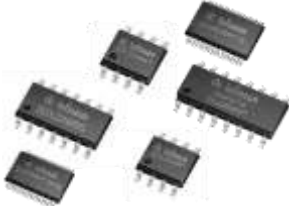
A wide roadmap dedicated for HV power switch technologies



$R_{DS(on,max)}$ [mΩ]	PG-TJ247-3	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

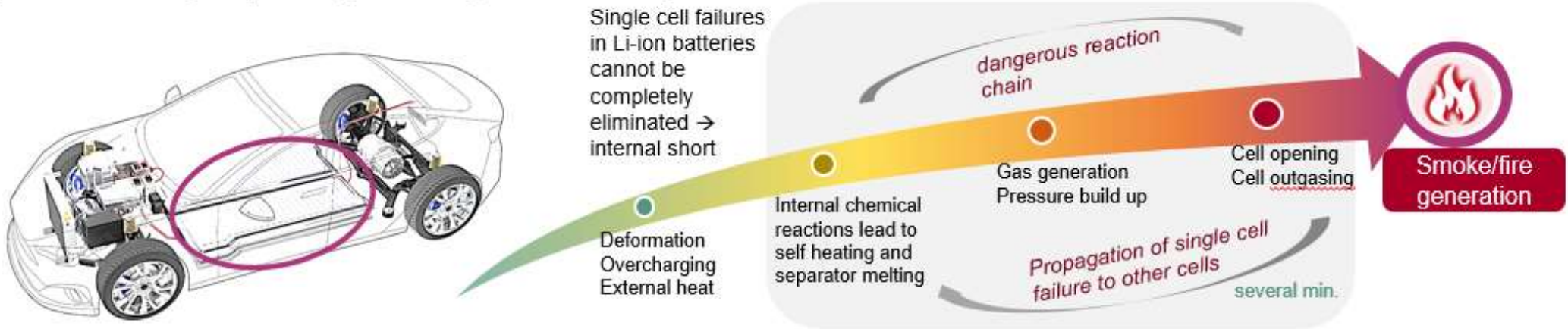
power	driving	sensing	control
CoolMOS™ S7A	EiceDRIVER™	XENSIV™	AURIX™
 > 10mΩ BiC > 800A pulse current > High power SMD > Kelvin Source 600V-800V N-Channel Automotive MOSFET - Infineon Technologies	 > Safe operation > High efficiency > Lower system size & weight Gate Driver ICs - Infineon Technologies	 > 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

Thermal Runaway challenge

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

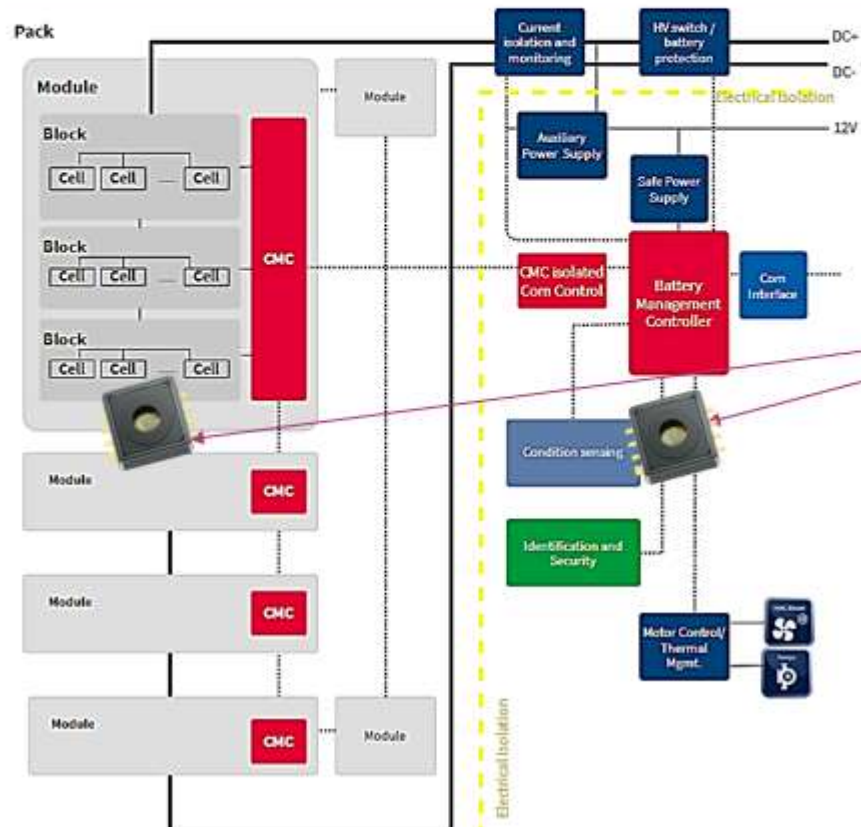


3 level strategy of reducing hazards caused by TR

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.

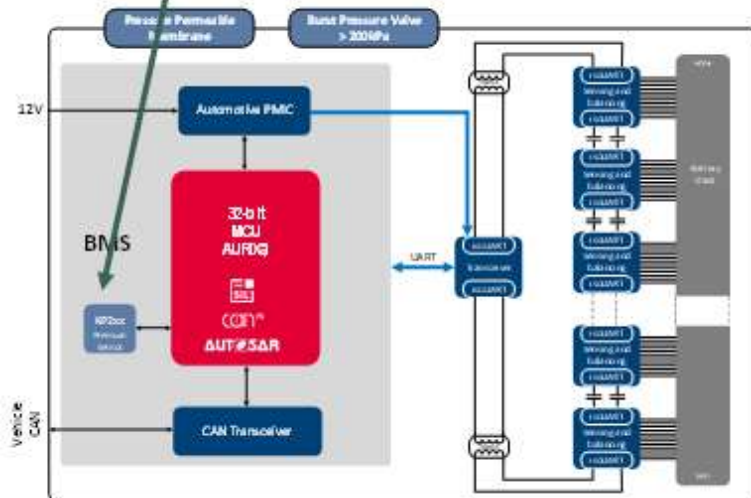
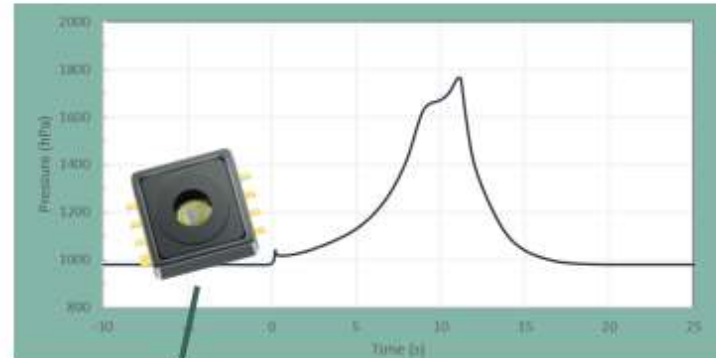


Barometric Pressure Sensor for Thermal Runaway detection can be placed inside battery pack housing or inside central control box (BMS)

→ 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

$\Delta p = p_2 - p_1$

ECU pressure sensor (BAP)

p2

p1

Option 2

$p = p_2 \rightarrow p_1$

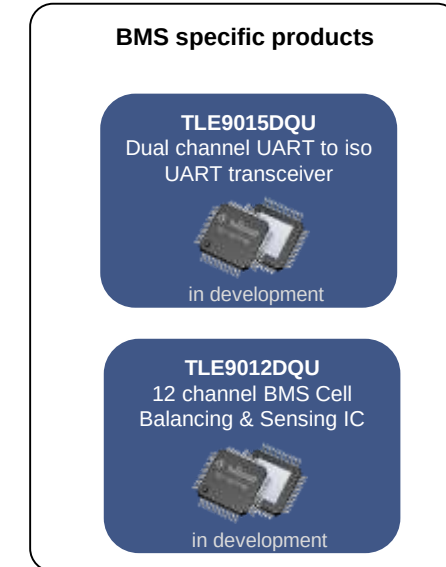
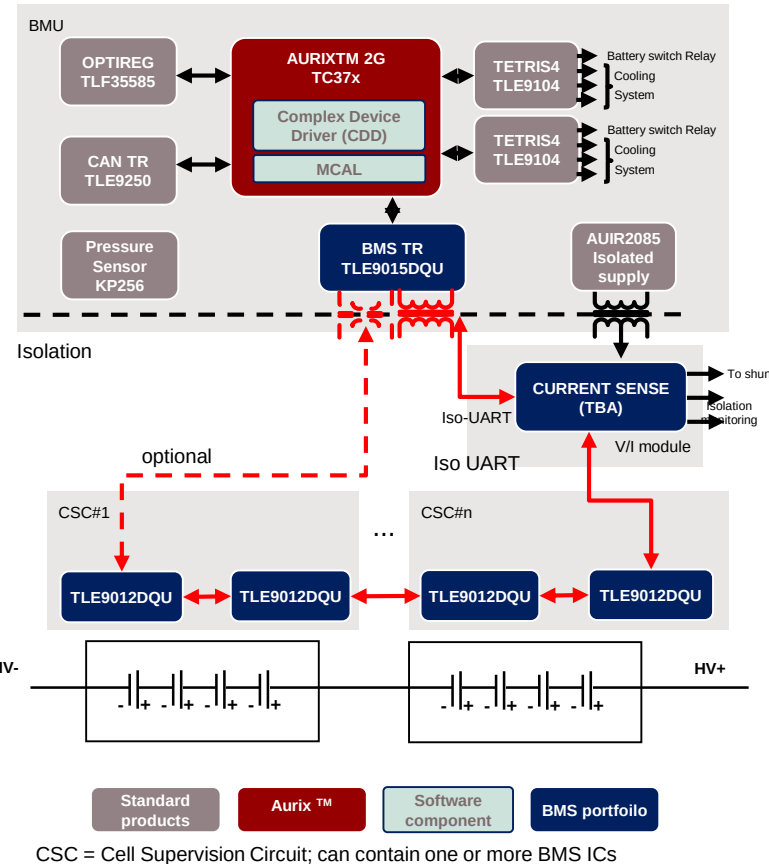
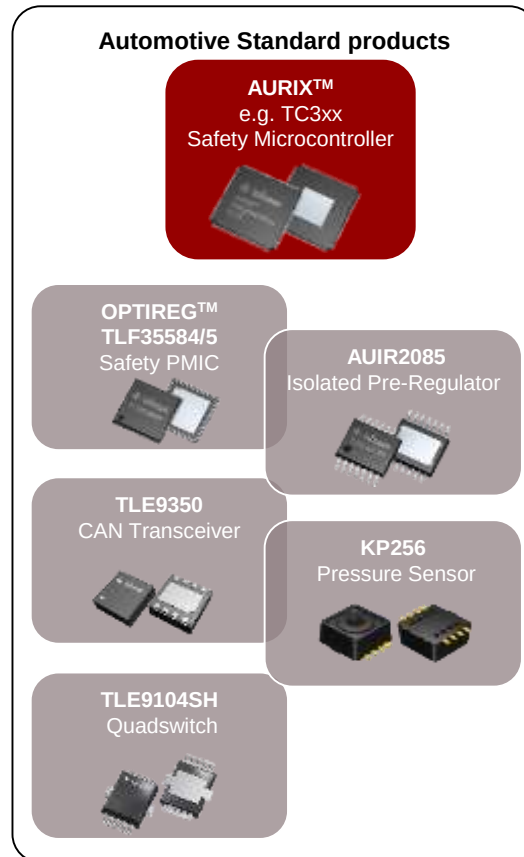
$\Delta p = p_2 - p_1$

Overview of the pressure sensors for BMS application

60 kPa	165 kPa	
Analog		
	KP236N6165	-40 → 125°C 0.2 → 4.8 V
	KP253	-40 → 125°C 12 bit
	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



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!