英飞凌BMS整体解决方案
线上案例分享与技术讨论会

博最科技 B&Z TECH

大聯大控股 品佳集團 SAC Group

Infineon

英飞凌整体解决方案暨合作伙伴BMS技术分享会

张昌明

英飞凌汽车电子事业部
BMS应用市场经理

罗海兵

英飞凌汽车电子事业部
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专案经理

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上海博最科技
产品总监

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英飞凌是一家全球领先的半导体企业

约50,280名
员工[1]

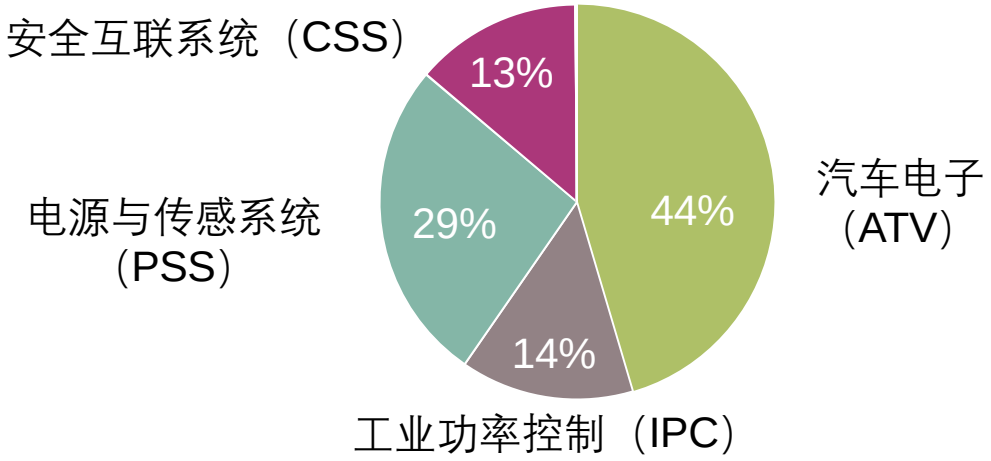
领导者
在汽车电子、电源能效管理和物联网等领域

9%+ I 19% I 13%
目标运营模式[2]

[1]截至2021年9月30日
[2]营收同比增长9%以上；运营利润率19%；投资占销售额的比例13%；随着赛普拉斯整合过程的推进，将逐渐达成目标

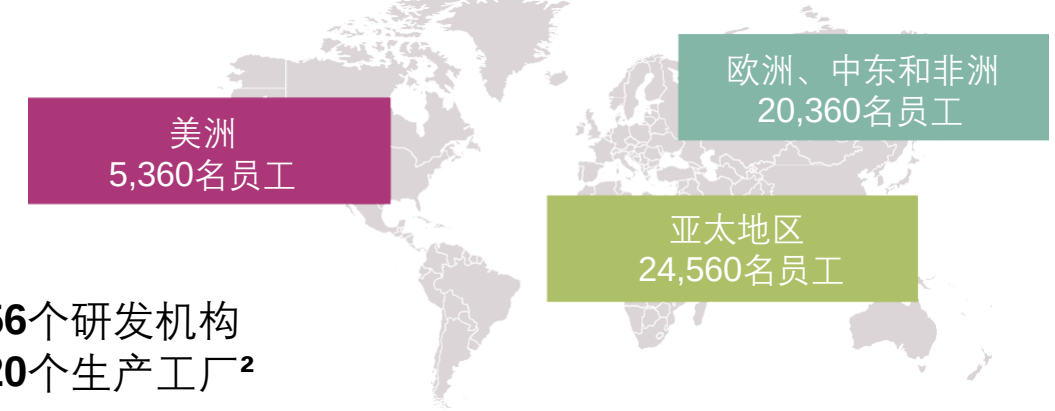
英飞凌概况

业务部门营收[1]



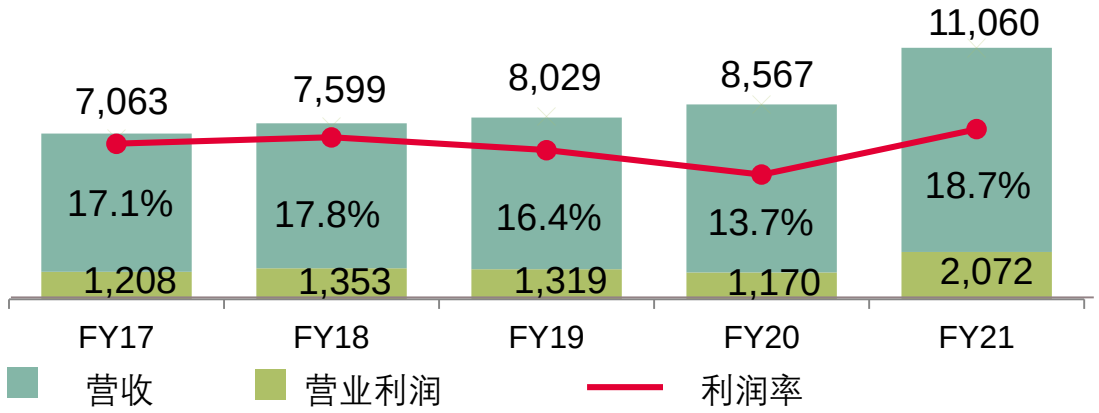
员工[1]

英飞凌在全球拥有**50,280**名员工



56个研发机构
20个生产工厂[2]

财务数据



*2021财年（截至2021年9月30日）
**截至2021年9月30日

市场地位

汽车电子	功率半导体	微控制器
		
# 1	**# 1**	**# 4**
Strategy Analytics, 2022年3月	Omdia, 2021年9月	Omdia, 2022年4月

如欲了解更多信息，请访问：英飞凌2021年度财务报告

丰富的汽车半导体产品线覆盖全汽车应用领域

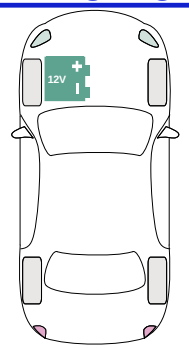
车身	仪表/ 信息娱乐系统	底盘/安全	动力总成	高级辅助驾驶/自动驾驶
传感器 (磁性, 压力, 雷达, 电流, 3D ToF, TrueTouch®, CapSense®)				
微控制器 (嵌入式电源集成电路, PSoC™, Traveo™)		**微控制器 (AURIX™)**		
存储器 (NOR Flash, SRAM, nvSRAM, F-RAM)				
功率 (MOSFETs, IGBTs, modules, driver ICs, power ICs, LDOs, PMICs, USB Type-C PD)				
互联 (USB)	**互联 (Wi-Fi, BT, BLE)**			
汽车电子应用领域示例:				
› 空调 › 车门控制 › 泵 › 座椅调节 › LED尾灯照明 › 前车灯 › 座椅加热 › 无线车充	› 仪表盘 › 座舱娱乐 › 触摸 › 座舱充电	› 制动 › 转向 › 电子稳定系统 › 主动悬挂系统 › 底盘域控制器 › 防抱死系统 › 安全气囊 › TPMS	› 引擎管理 › 传动 › 主逆变器 › 辅助系统 › 48V微混合动力 › 变速器 › 电池管理系统 › 车载充电器	› 车速控制 › 紧急制动 › 盲点监测 › 传感器融合 › 雷达系统 › 环视系统

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

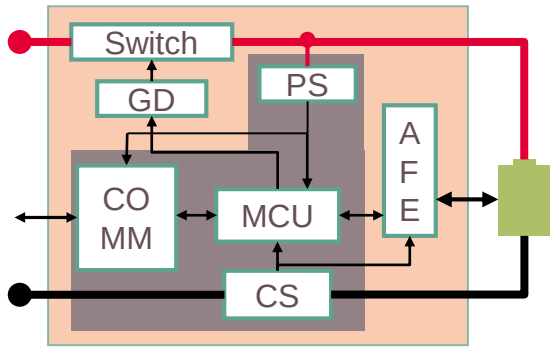
12 V

All Vehicles



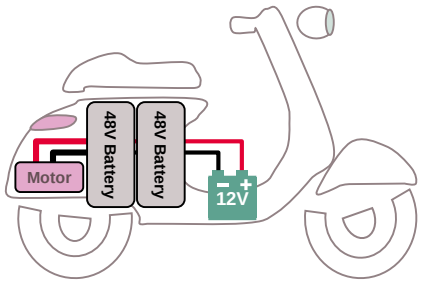
< 2 kWh

Lead acid | **Lithium ion**

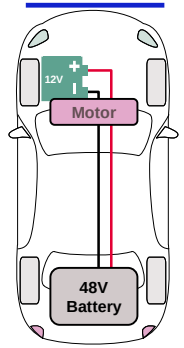


48 V

E2Ws

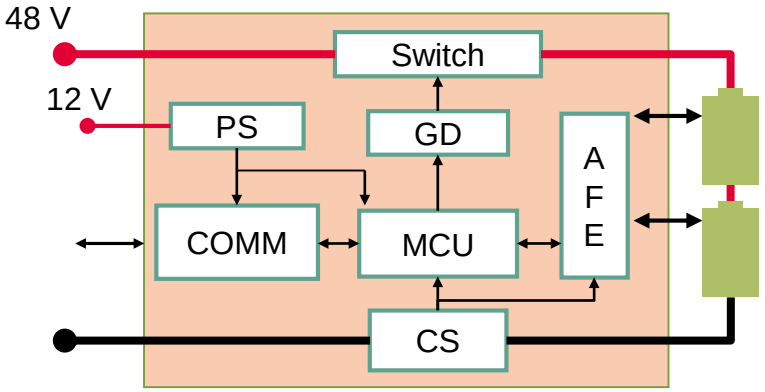


MHEV



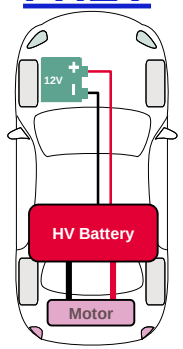
5–15 kWh

Lithium ion

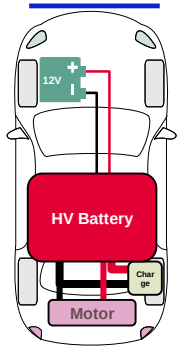


400/800 V

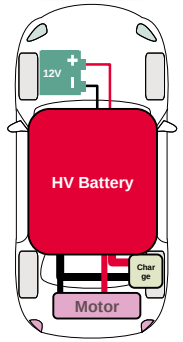
FHEV



PHEV

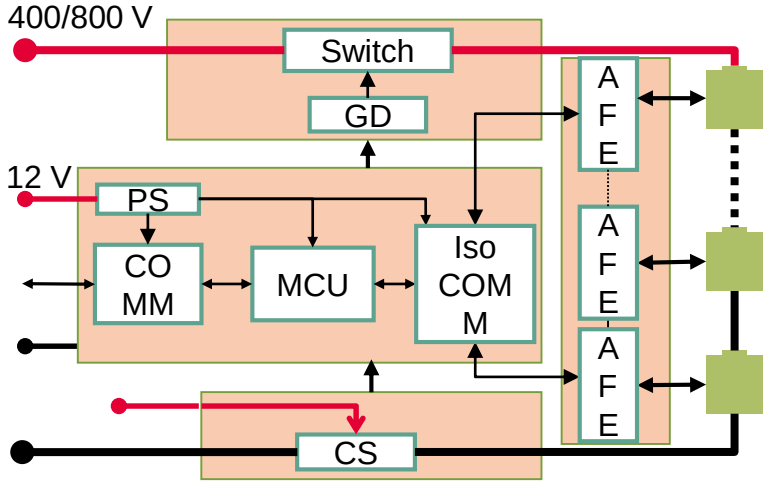


BEV



20–25 kWh | > 25 kWh | > 50 kWh

Lithium ion



Infineon Roadmap for Wired and Wireless BMS P2S Offering

	Short term solutions Samples available, all PPAP within 1.5 Y		Roadmap solutions (all PPAP within 2024)	
Wireless	**TLE9012DQU** 12 Channel ASIL D AFE	**CYW89820** Bluetooth chip	**PSoC HVBMS256K** Integrated 18ch ASIL D AFE and BLE	
	TLF35584 or **TLF35585** Safety Power Supply	**PSoC HVPA208K** ASIL-C Current Sensor	**TLF35584** or **TLF35585** Safety Power Supply	**PSoC HVBMS256K-VIO** Integrated 18ch ASIL-D AFE and BLE with Current/Isolation Sensing
	AURIX TC3xx Safe and Secure MCU		**AURIX TC3xx** Safe and Secure MCU	
Wired	**TLE9012DQU** 12 Channel ASIL D AFE	**TLE9015DQU** ISOUART Transceiver	**TLE9018LS/TLE9012LS** 18/12 Channel ASIL D AFE	**TLE9015LS** ISOUART Transceiver
	TLF35584 or **TLF35585** Safety Power Supply	**PSoC HVPA208K** ASIL-C Current Sensor	**TLF35584** or **TLF35585** Safety Power Supply	**PSoC HVBMS192K-VIO** (ASIL D) with voltage/ current/isolation sensing or **PSoC HVPA208K** (ASIL C)
	AURIX TC3xx Safe and Secure MCU		**AURIX TC3xx** Safe and Secure MCU	

Future proof portfolio, with advanced features, like overcurrent, isolation and impedance measurement capabilities

Robustness, with field proven technology

Cost efficiency, highly integrated system solution, reducing customer's development efforts and time to market

Interoperability, products designed to work together and reduce customer's effort and time to market

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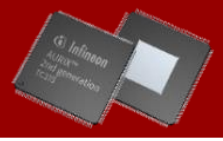
Infineon battery management system (BMS) chipset overview
TLE9012DQU Balancing & Sensing IC

Automotive Standard products

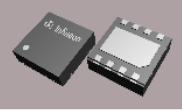
AURIX™
e.g. TC3xx
Safety Microcontroller



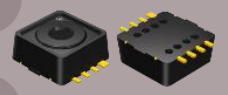
OPTIREG™ TLF35584/5
Safety PMIC

AUIR2085
Isolated Pre-Regulator

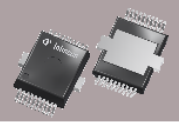
TLE9350
CAN Transceiver

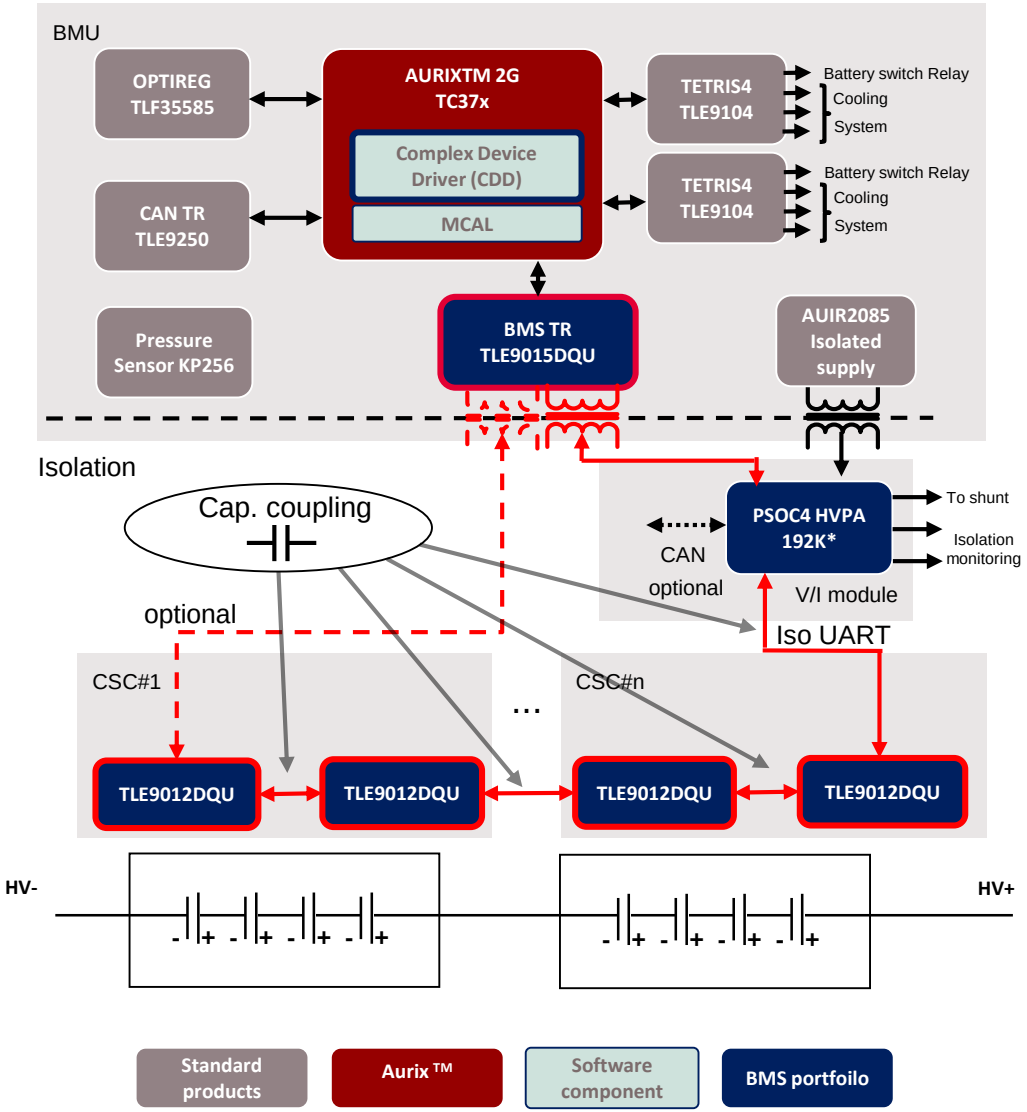


KP256
Pressure Sensor



TLE9104SH
Quadswitch





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

BMS specific products

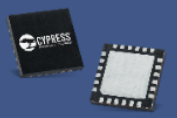
TLE9015DQU
Dual channel UART to iso UART transceiver

in release

TLE9012DQU
12 channel BMS Cell Balancing & Sensing IC

In release

PSoC 4 HVPA 192k*
Accurate current sensor w/ ARM M0+ core



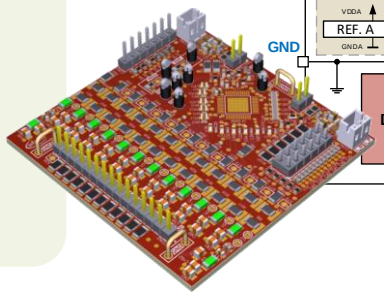
in development

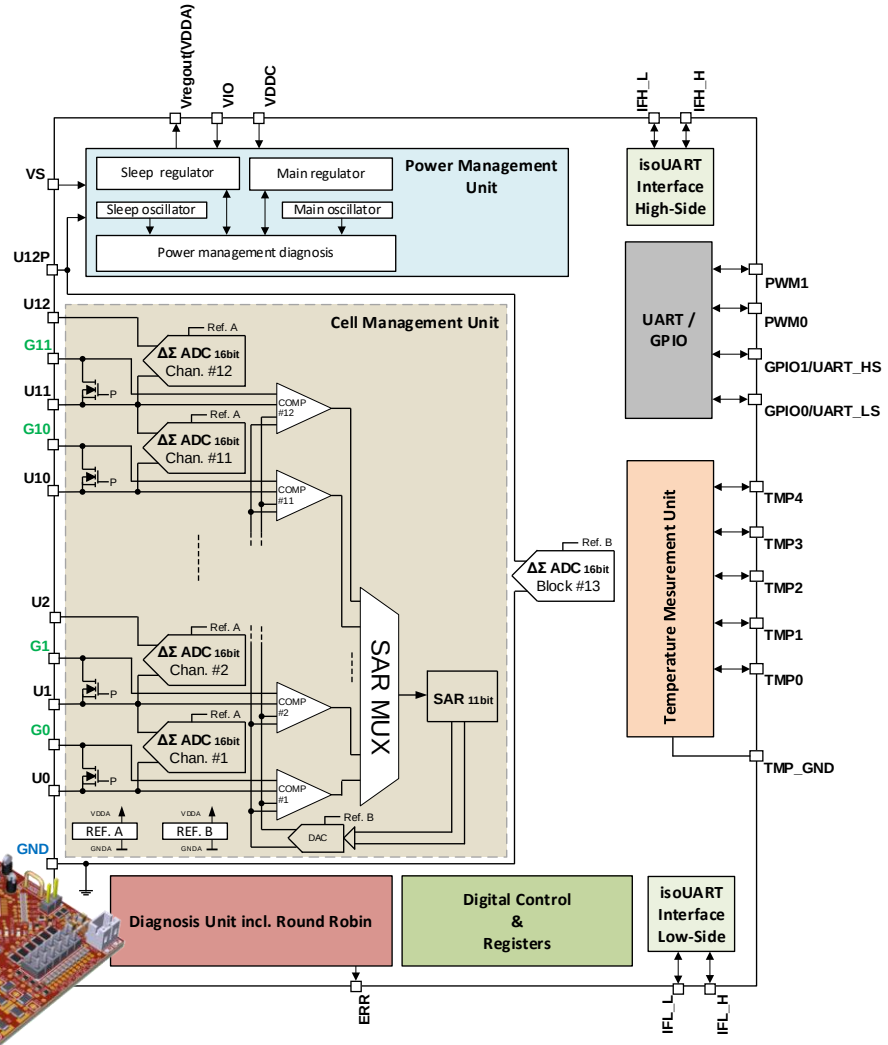
*isoUART compatibility under evaluation

TLE9012DQU
12ch balancing and monitoring IC supporting ASIL D systems

Key benefits

- Balancing & monitoring for up to 12 cells in series
- Robust Infineon 90V/130nm automotive technology supports hot plugging and enables digital features
- Dedicated 16-bit delta-sigma ADC per cell enabling synced & filtered measurements
  - Several built-in digital filtering (down to 70Hz cut-off)
  - Long running ADC mode with adaptive sample times for up to ~92ms (<10Hz cut-off) averaging.
- Secondary ADC with same filter characteristics for a synced cell voltage plausibility as advanced End-to-End safety mechanism
- 13th DS-ADC with the same filter characteristics for synced block voltage measurements
- Compatible with Infineon complex device driver for TC3xx
- 5 NTC channels + additionally 4 GPIOs to connect e.g. an external EEPROM
- UART & robust capacitive coupled interface for daisy chain & ring mode communication
- Supporting up to ASIL-D BMS safety applications
- Small package (TQFP-48) & high feature integration for a lean external BOM





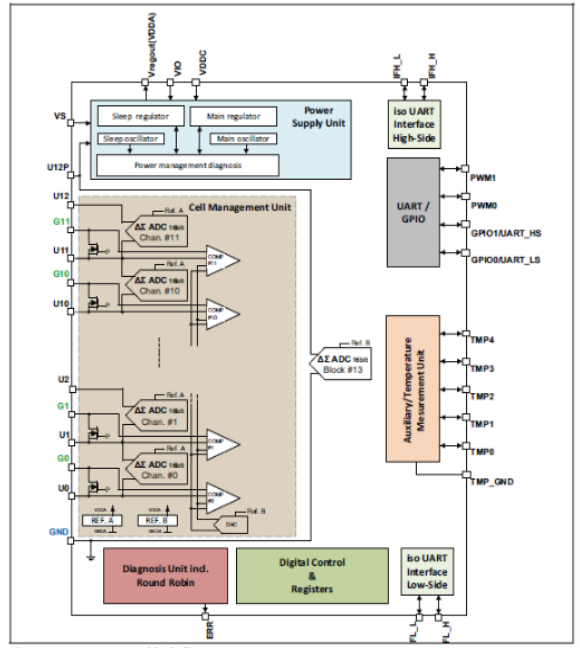
TLE9012xQU features enabling cost down
Infineon BMS

Robustness and reliability

EOL guaranteed accuracy (no end-of-line trimming)	Robust Automotive Technology	Integrated Diagnosis
Integrated Stress sensor guarantees accuracy over lifetime	Million times in field proven >90V automotive technology	Supports self triggered regular checks for voltage, temp. and internal fault detection

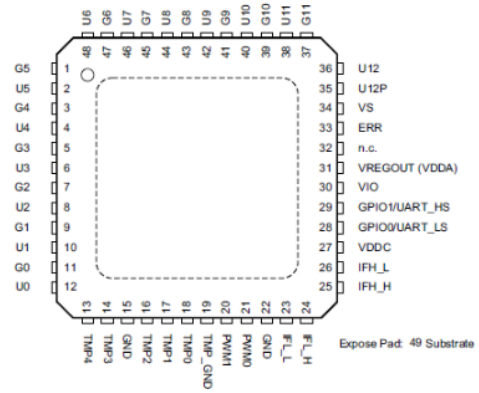
Performance

12x ADC for Cell Voltage Measurement	5 Temperature Sensors with adaptive current source	Integrated passive balancing
Provides digital filtering reducing cost of external filter	Supports a wide range of NTCs (400Ω to 400kΩ) with no need to change HW	Up to 150mA internally. Voltage monitoring available during balancing



Communication

IFX's Highly Robust Capacitive Coupled communication offers the key advantages to **reduce the system cost**



Innovative features offering **cost down** and **size optimization** for state-of-the-art BMS

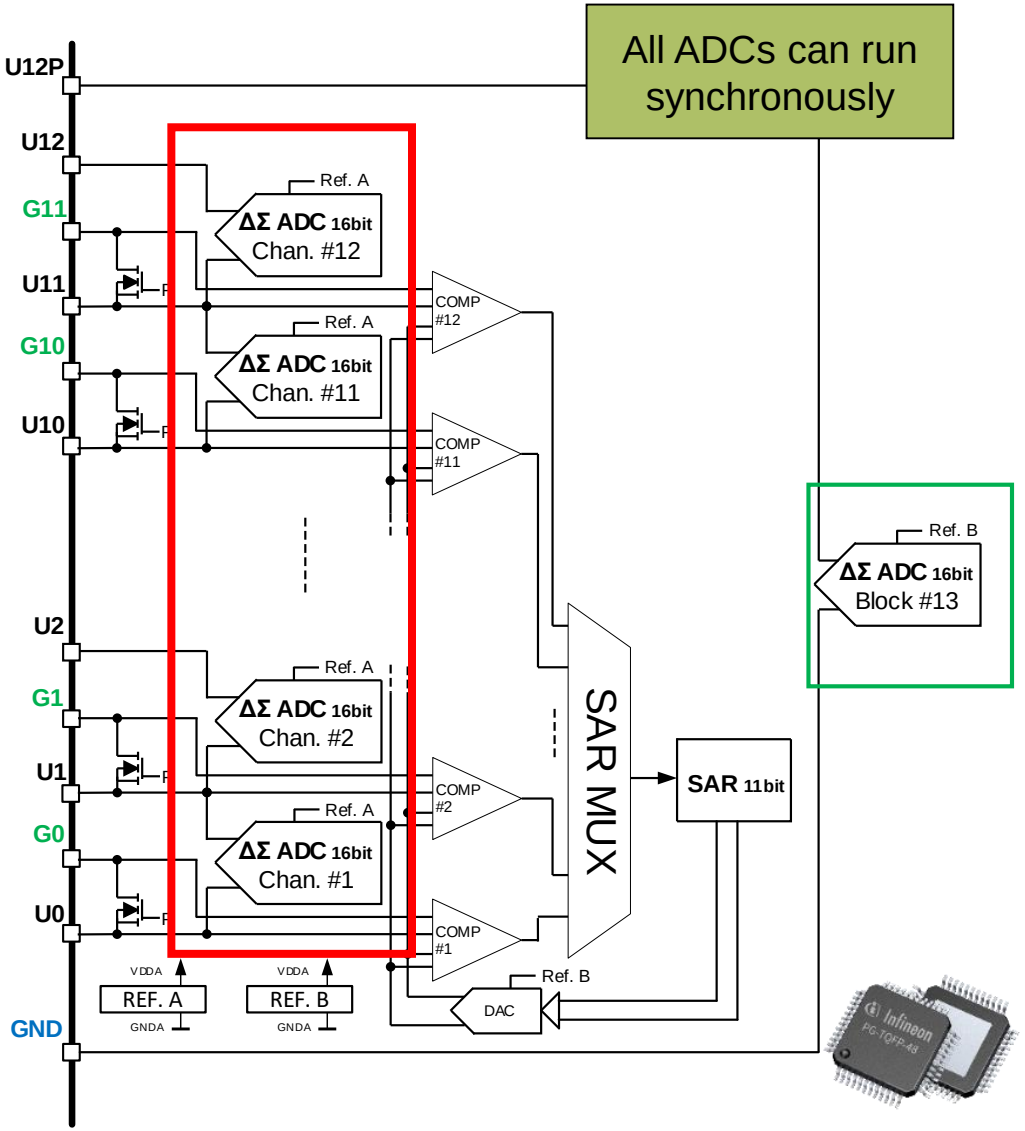
TLE9012DQU a unique ADC architecture

TLE9012DQU unique ADC architecture

- The TLE9012DQU includes **thirteen 16-bit delta-sigma (DS) ADCs**
- The architecture combines all important Vcell measurements aspects
  - **Highest accuracy,** enabled by 16-bit DS-ADC technology
  - **Superior noise rejection,** enabled by high internal over sampling
  - **Advanced sync-on-sample,** enabled by the parallel architecture

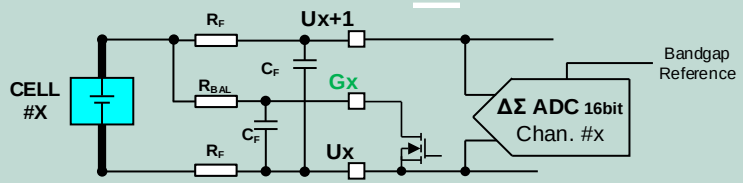
TLE9012DQU accuracy performance considerations

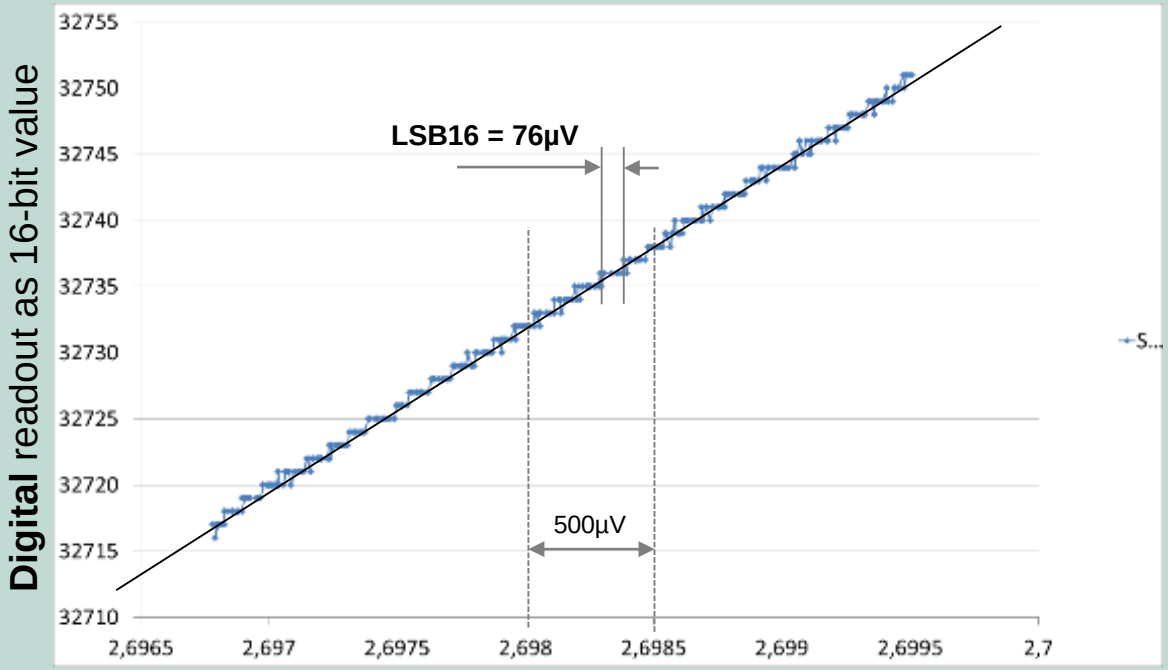
- Choosing a million time in-field proven Infineon automotive technology (SPT9, 90V/130nm) for highest reliability and lifetime performance
- Design & chip layout optimized to minimize the stress on all sensitive circuitries + stress sensor compensation for remaining mechanical stress
- Each 16-Bit ADC is individually calibrated & temperature compensated for highest relative and absolute accuracies



The DS-ADC characterization shows **superior intrinsic linearity & measurement result repeatability** as basis for highest accuracy

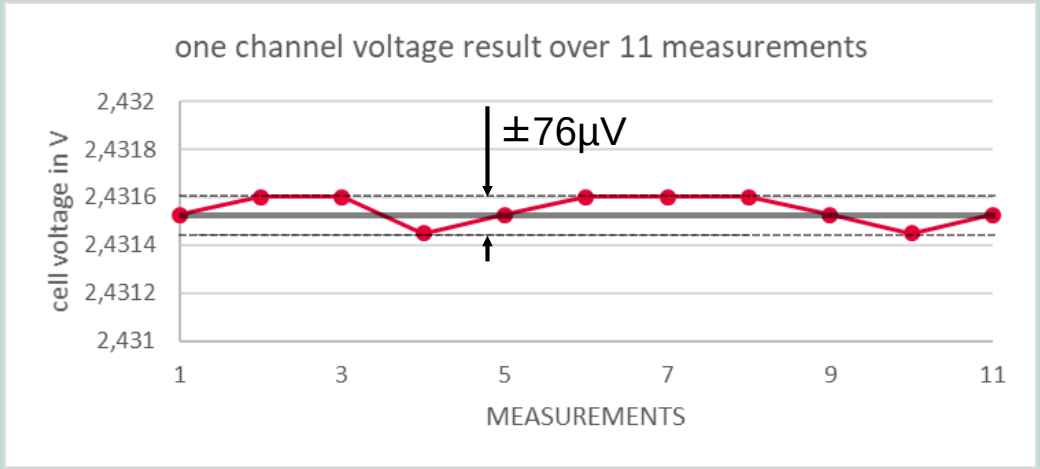
Analog-to-digital conversion characterization





Slowly ramping the applied **analog** voltage

Highest measurement **repeatability**

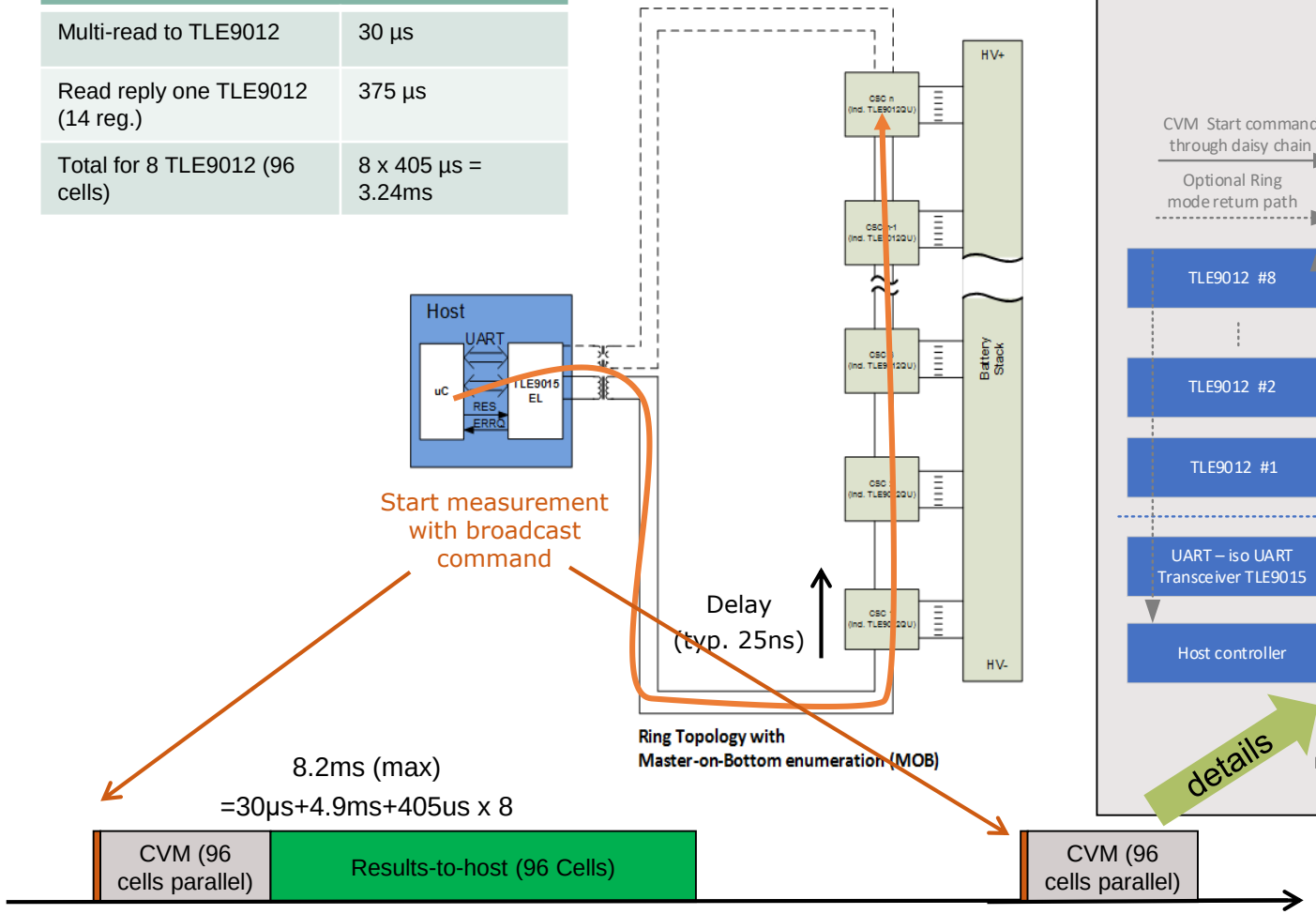


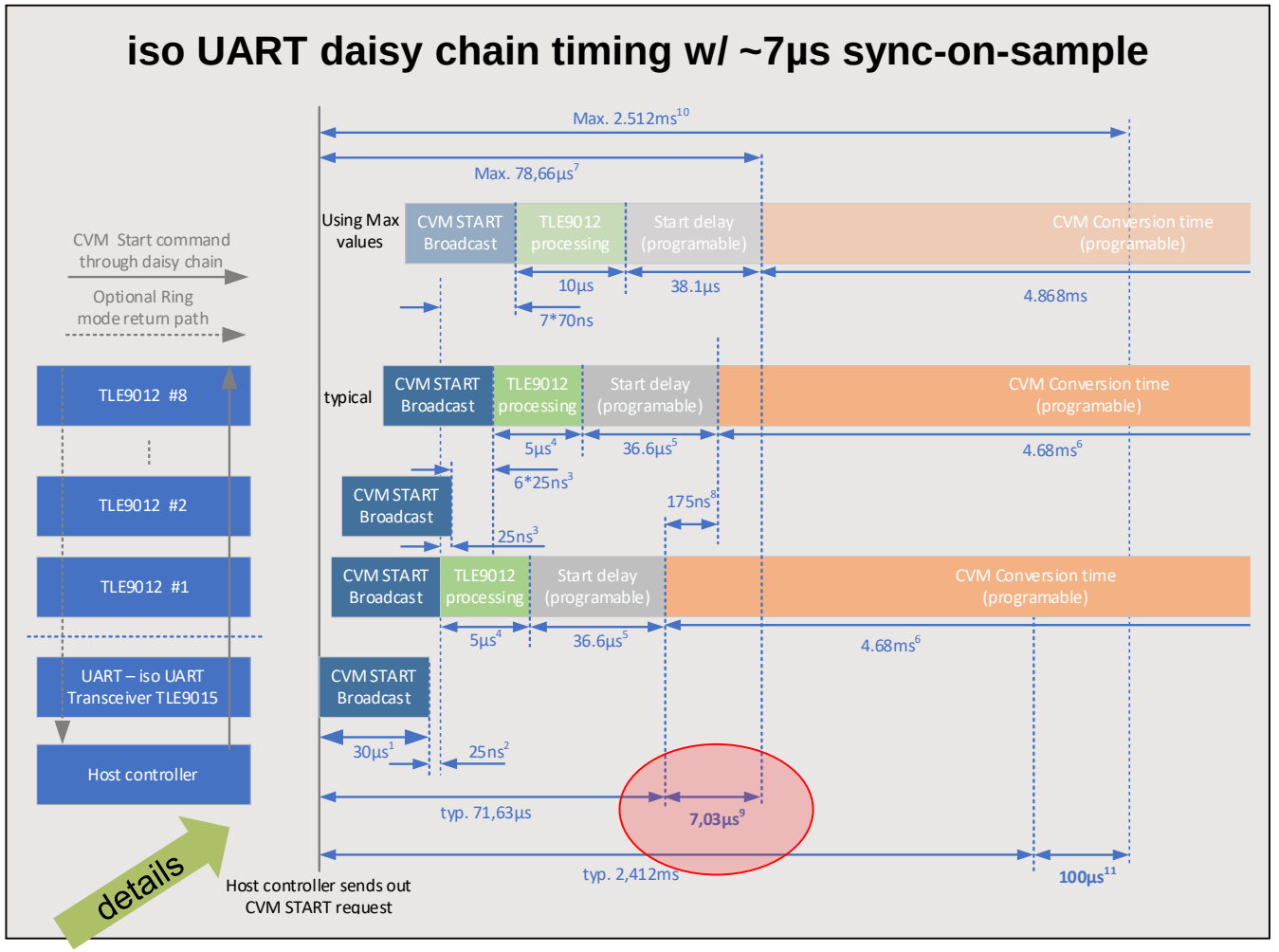
Standard deviation for this 11 results ~60µV

A **high intrinsic ADC repeatability** fits perfectly to the **BMS application**

TLE9012DQU Fast & synced cell voltage sampling
~7µs sync-on-sample for 96 cells & 2 Mbit/s iso UART

Timing readout of 96 cell voltage results using multi-read command (14 Reg. = 12 Cells + SCVM + BVM)	
Multi-read to TLE9012	30 µs
Read reply one TLE9012 (14 reg.)	375 µs
Total for 8 TLE9012 (96 cells)	8 x 405 µs = 3.24ms





Infineon specifies all TLE9012DQU accuracies as **end of life**

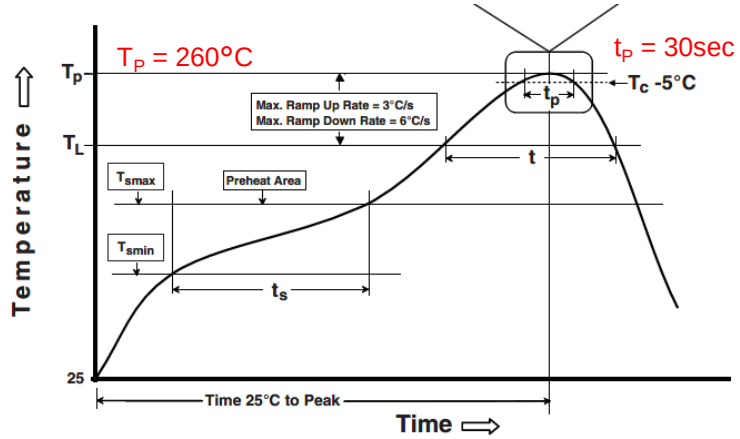
› Infineon specifies all accuracies as **end of life**. We use the AEC-Q100 qualification data which is simulating 15 years of device lifetime to define our end of life accuracies. Here the stress tests which are part of the AEC-Q100:

AEC Q100 stress tests

Assumed 15 years lifetime according to **AEC Q100 grade 1 (-40°C ≤ T_j ≤ 150°C)**

STRESS TEST	ABV	TEST METHOD	REQUIREMENTS S.S	REQUIREMENTS # LOTS
Preconditioning	PC	JEDEC J-STD-020	Min. MSL = 3	
Temperature Humidity Bias or HAST	THB / HAST	JESD22-A101/A110	77	3
Autoclave or Unbiased HAST	AC / UHST	JESD22-A102/A118	77	3
Temperature Cycle	TC	JESD22-A104	77	3
Power Temperature Cycling	PTC	JESD22-A105	45	1
High Temperature Storage Life	HTSL	JESD22-A103	45	1
High Temperature Operating Life	HTOL	JESD22-A108	77	3
ESD - Human Body Model	HBM	AEC Q100-002	See Test Method	
ESD - Charged Device Model	CDM	AEC Q100-011	See Test Method	
Latch-Up	LU	AEC Q100-004	6	1
Electrical Distributions	ED	AEC Q100-009	30	3

Preconditioning to mimic reflow soldering



1. Passing AEC Q100 means all devices (S.S) from all lots are within Min/Max of all specification parameters after the end of each stress test. All accuracy End-of-Life parameters must pass AEC Q100.

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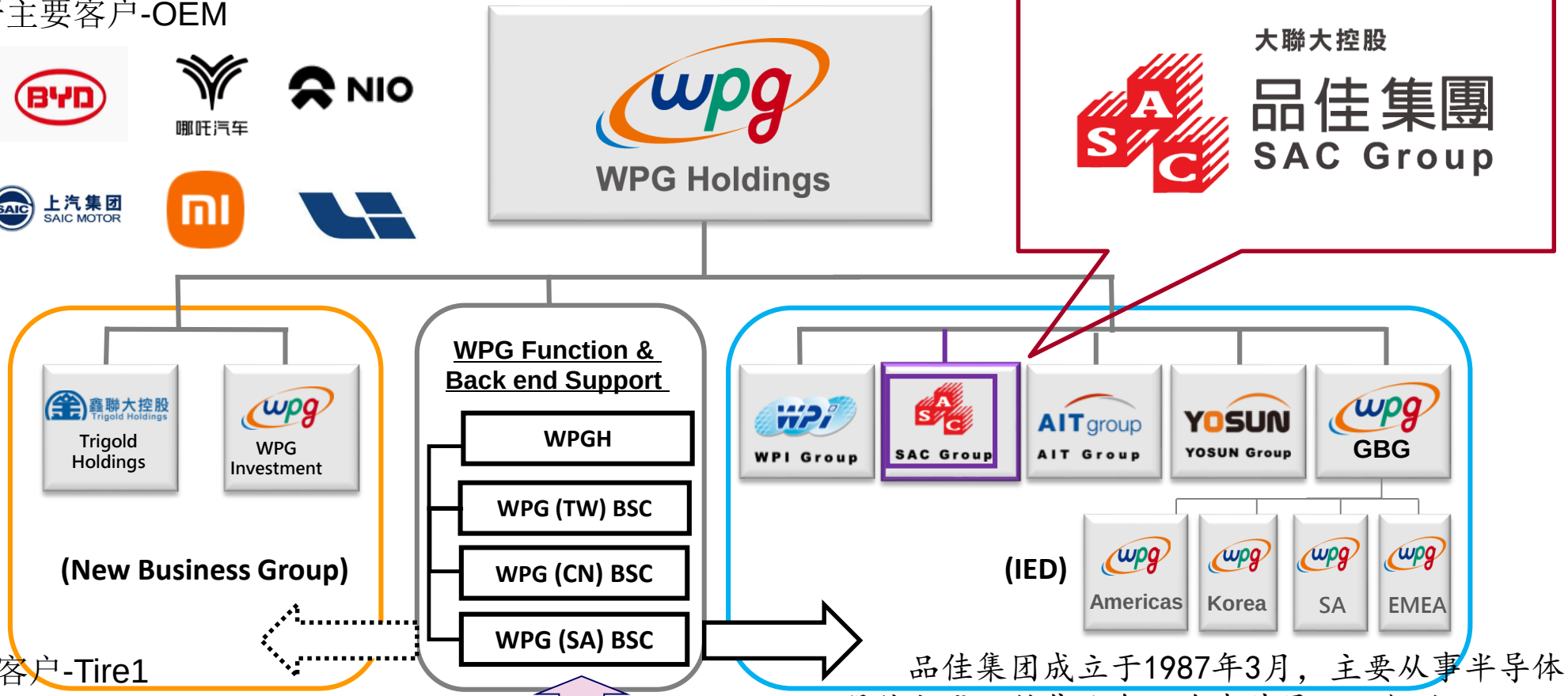
WPG Holdings Organization

汽车电子主要客户-OEM

长城汽车 BYD 哪吒汽车 NIO 吉利汽车 GEELY AUTO 上汽集团 SAIC MOTOR



汽车电子主要客户-Tire1

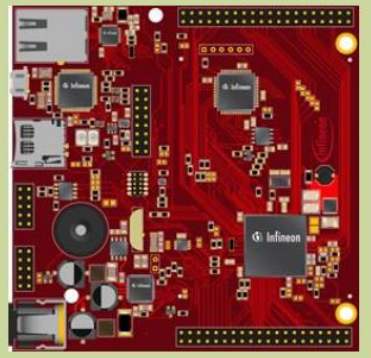
WODEER 沃德尔 WHST 森思泰克 科大国创 GUOCHUANG 蔚隆汽车 LUXSHARE ICT AUTOMOTIVE INTERFACE SOLUTIONS Visteon BYD META SYSTEM ecarx MIND THB

WPG Back-end Support
- Finance Support
- HR Management
- Warehouse & Logistics
- Supply Chain Platform

品佳集团成立于1987年3月，主要从事半导体元器件之代理销售业务，海内外员工人数约645人，2021年集团营收逾35,04亿美金。随着规模的扩大以及客户需求的不断提升，品佳集团可提供不同难度及层次的技术支持。「系统整合(System Integration)及参考设计方案提供(Solution Provider）」的含量也持续提高，

BMS demo overview

KIT_AURIX_TC265_TFT (SP001303908)
or
TC397_TFT



TLE9015DQU eval board works as adapter connecting onto the AURIX board

BATTERY SYSTEM

BMU/BMC

12V & GND

PMIC TLF35584/5

CAN

CAN TR TLE9250

AURIX

- Thermal control
- SoC & SoH
- Charge control
- Safety control

UART

BMS TR TLE9015

iso UART

LV (12V) | HV

Ring optional

CSC#n

BMS IC TLE9012

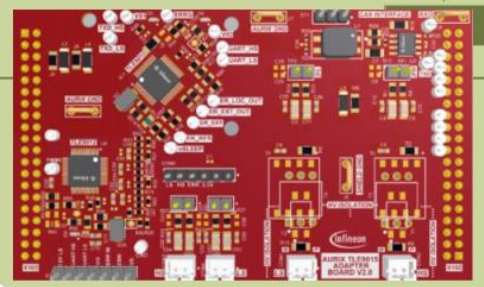
CSC#1

BMS IC TLE9012

Cells

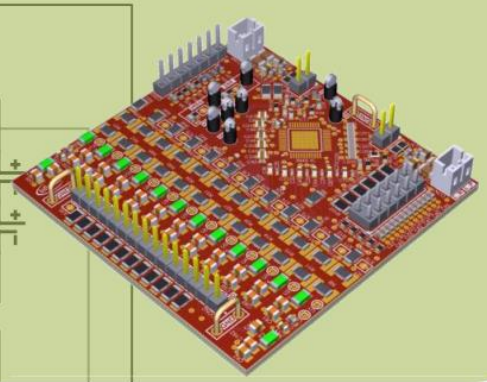
TLE9015DQU_TRX_BRG

- TLE9015DQU v2 UART to iso UART
- SP005355314



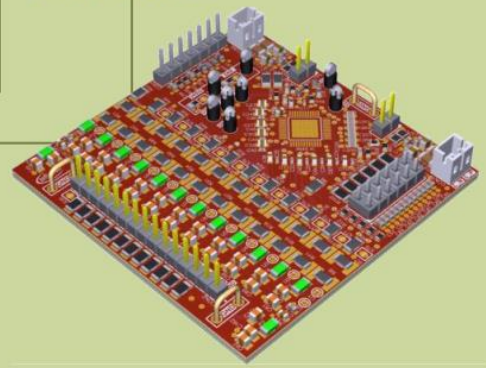
TLE9012DQU_DTR_BMS2

- TLE9012DQU v6 Evaluation Board
- SP005355307

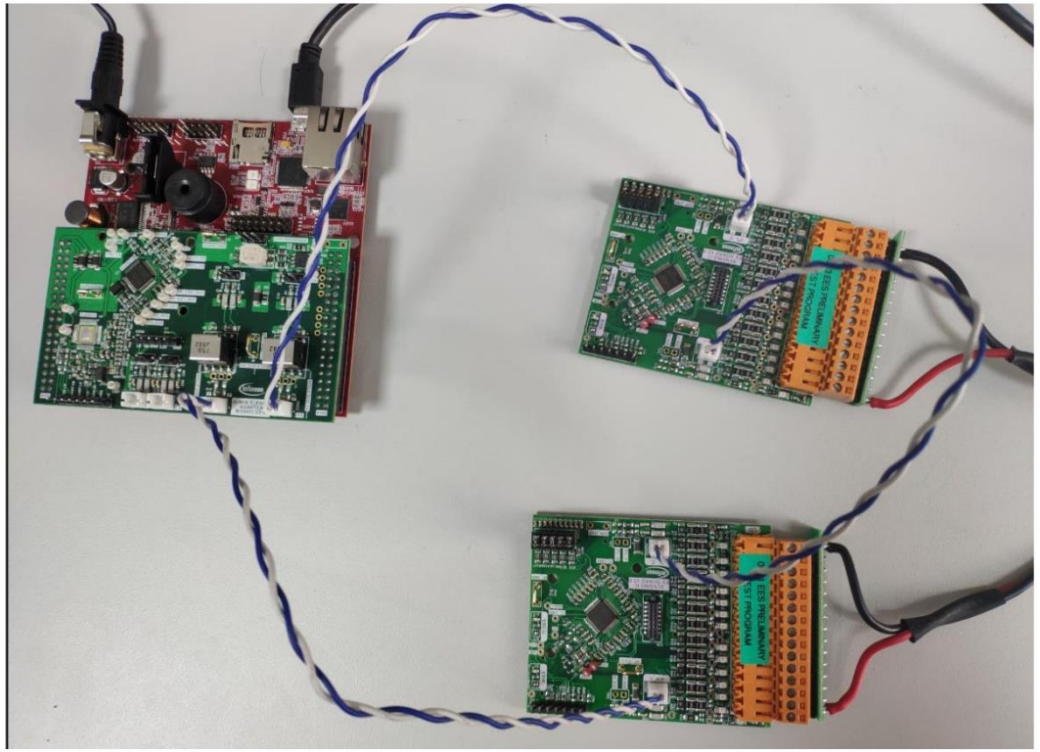


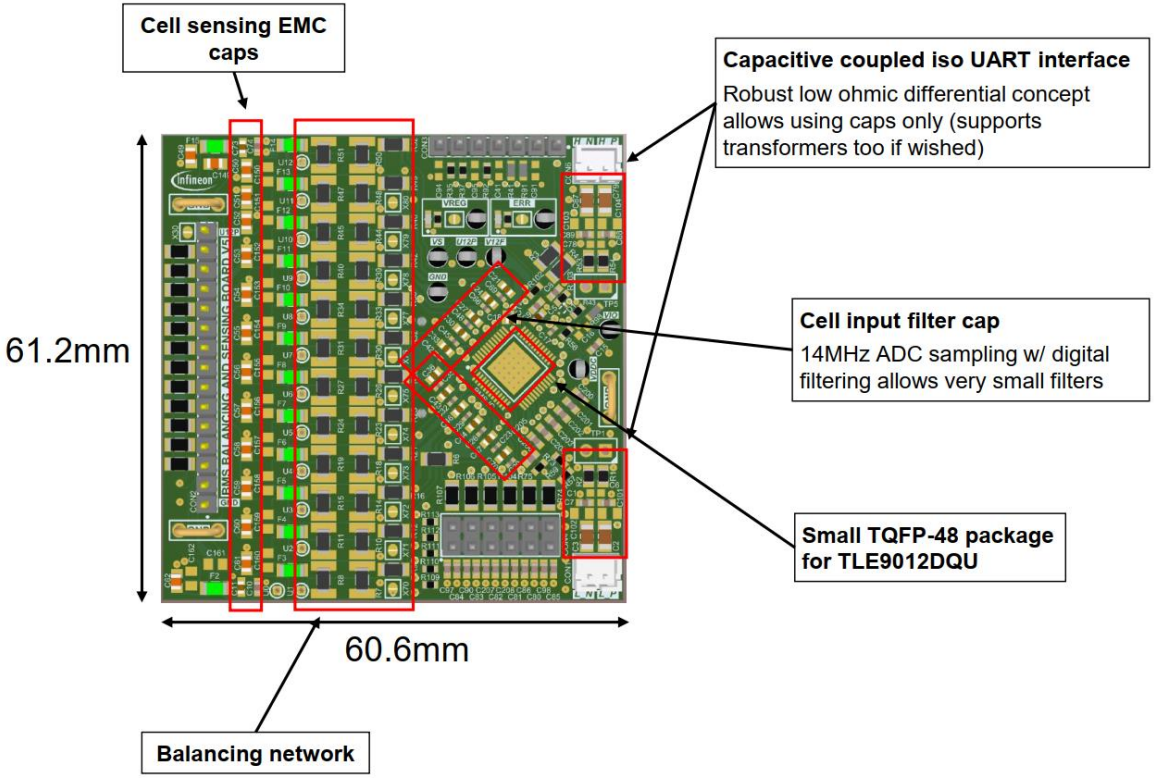
TLE9012DQU_DTR_BMS2

- TLE9012DQU v6 Evaluation Board
- SP005355307



测试环境搭建



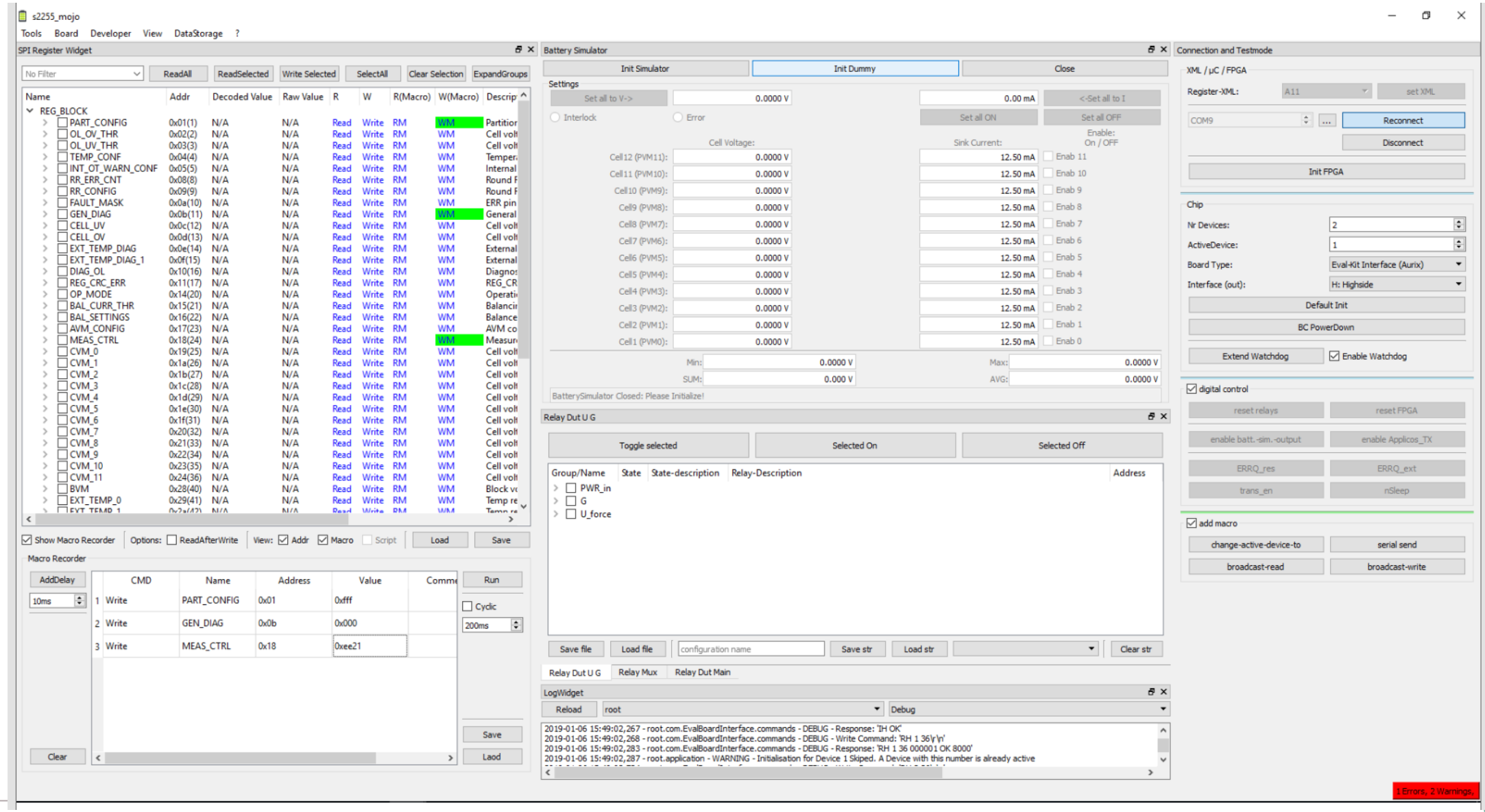


TC265 + 1 TLE9015 + 2 TLE9012 组成回环链；

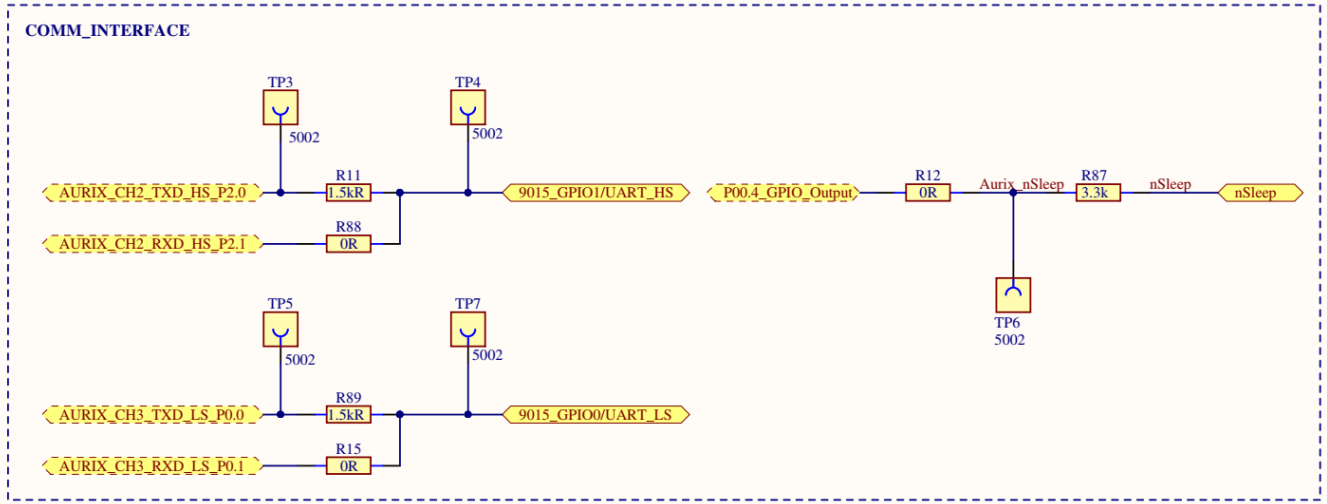
TLE9012 采样端可接电池模拟器进行采样测试；

TLE9012 demo 板功能简介

GUI overview



通信 & 初始化配置

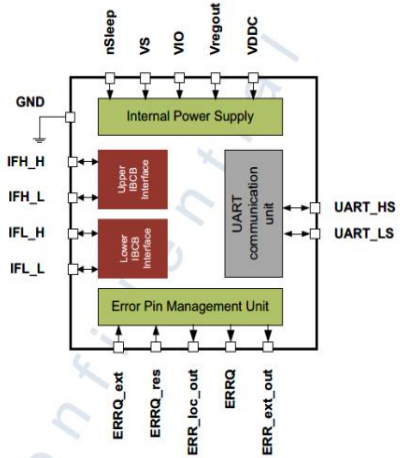


MCU & TLE9015 UART 通信部分原理图

TLE9015 UART_HS & UART_LS 可分别接到 MCU 的一组 UART，即一颗 TLE9015 可接到 MCU 两路 UART，其信号为差分信号，TX 串 1.5K 电阻，RX 串 0Ω 电阻。

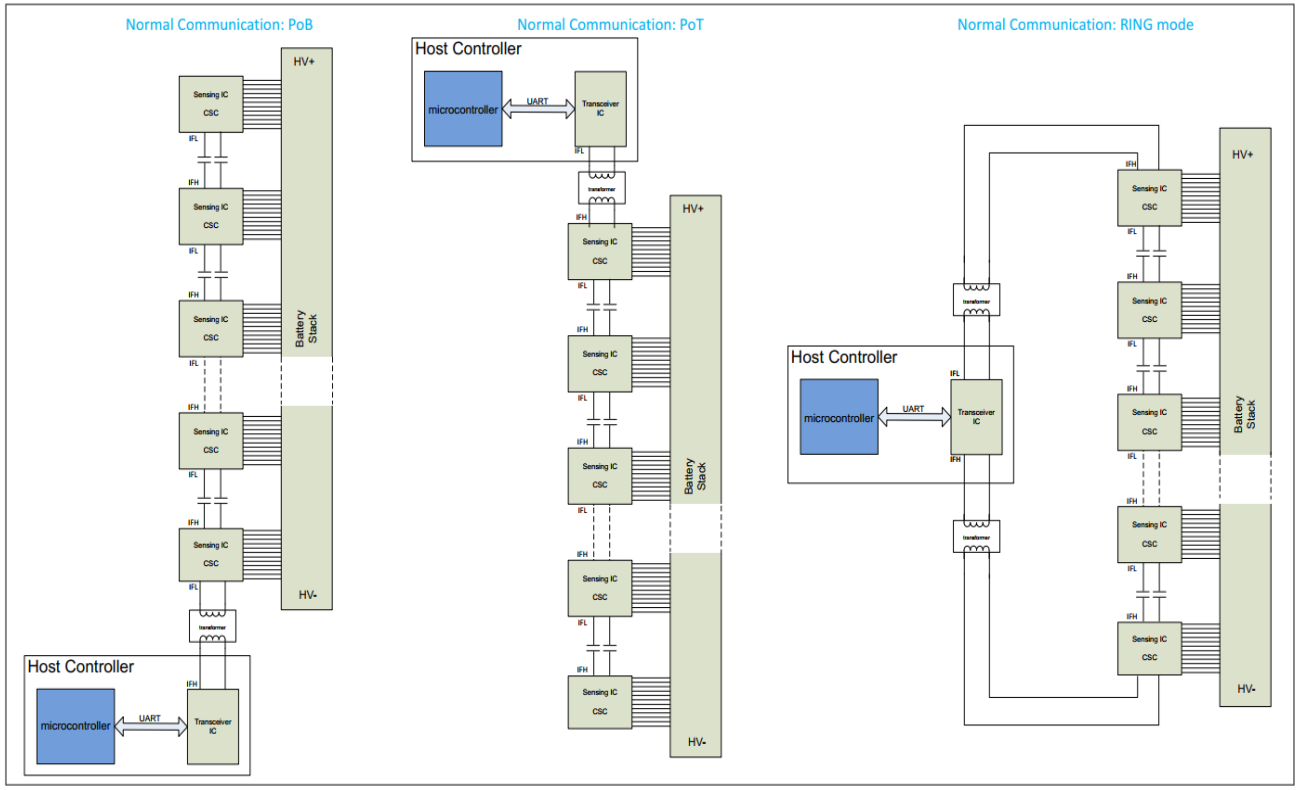
Key benefits

- Two UART ports for serial communication to host microcontroller supporting ring mode
- Two iso UART ports for daisy chain communication inside battery pack supporting ring mode
- Fully transparent communication scheme from µC to monitoring & balancing IC (TLE9012DQU)
- Supporting up to 2 Mbit/s
- High robustness against external noise
- Emergency signal detection during sleep mode
- General purpose error pin ERRQ to be connected to uC or PMIC for wake-up after emergency signal arrival

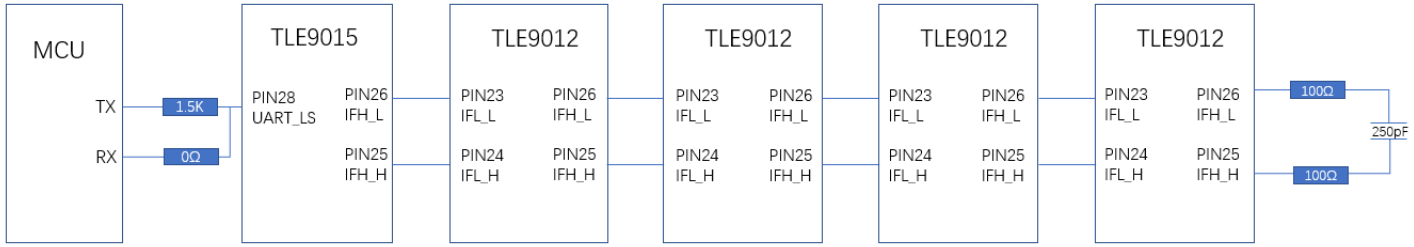


TLE9015 features

四种通信配置



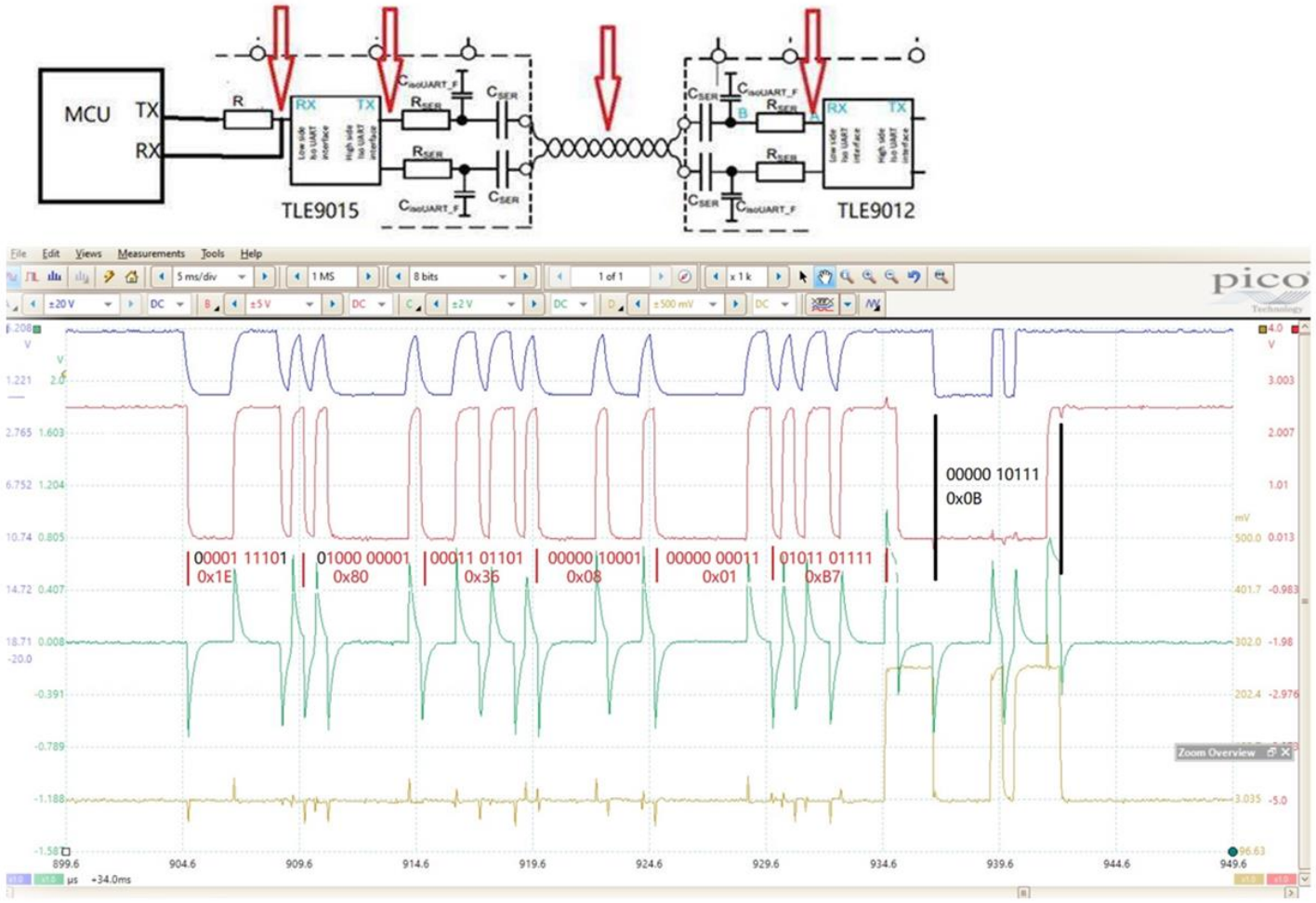
PoB communication



芯片共支持四种通信模式，在低压应用时可以通过 MCU 与 TLE9012 直连，高压应用支持 PoB、PoT、Ring mode。

建议的通信链路为 MCU 到 TLE9015 UART_LS，然后 IFH 出来再到 TLE9012 IFL，此后高接低，低接高，依次来连接，采样通信建议为 PoB。Layout 时用最低节电池对应的 TLE9012 靠近 TLE9015，可以避免高压的影响。

唤醒注意事项

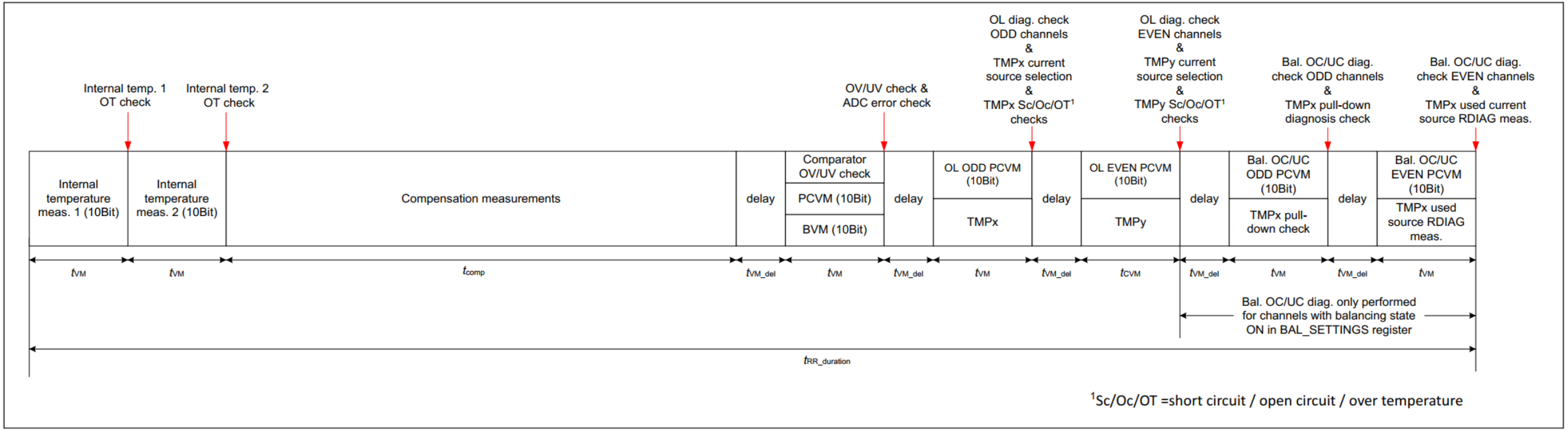


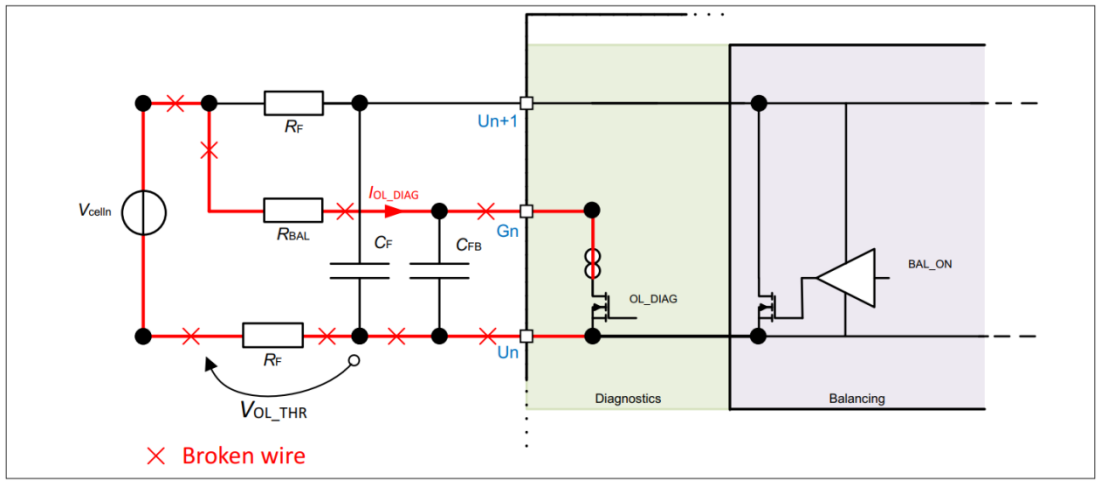
通信测试点 & 波形

初次唤醒发送两个 0XAA 指令，需要注意的是，MCU 发送完后 ，TLE9012 需要一定反应时间才能回复。所以 MCU 的 TXD 在发送时，RXD 同时也收到(此时读到的数据要不要使用由你们系统自行决定)，读完自己发送的部分后，要延迟一定时间才开始接收 TLE9012 回复的。

另外，从发送 0XAA 到 9012 醒来大约是 370ms，所以请注意发送 CONFIG 命令以及喂狗的时间，在 370ms 到 2ms 之间，早于 370ms 9012 还没有唤醒，晚于 2ms 又进入到休眠状态了。

诊断功能





Open Load detect

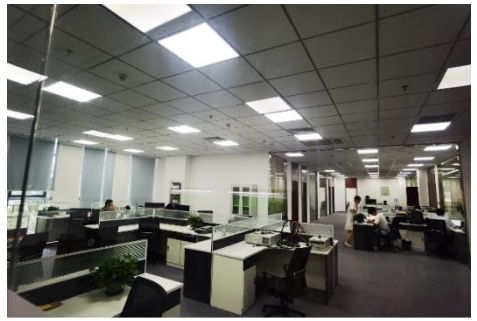
TLE9012 内部会自动执行一个轮询(RR)方案，它触发多次测量和内部诊断，以检查可能的故障，独立于任何通信命令。通过配置 Partition configuration 寄存器设置对应的通道开启测量和诊断功能。

Table of contents

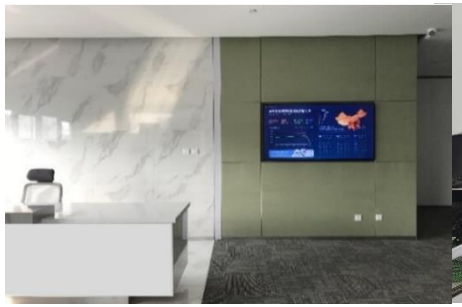
博最科技公司介绍

- 公司注册成立于2019年11月,坐落于上海国际汽车城.创新港.并在苏州设立研发制造中心,北京设立研发团队
- 聚焦新能源汽车电池,整车控制核心技术,独特供应链条,高竞争力产品化
- 专注于VCU+BMS
- 掌握行业细分领域核心资源:产品技术+制造能力,同时元器件采购供应能力尤为突出
- 核心团队技术产品与市场层面熟悉新能源汽车领域，均为十年以上新能源汽车从业经验
- 致力成为中国一流新能源整车控制、 BMS、电控产品服务商


上海总部

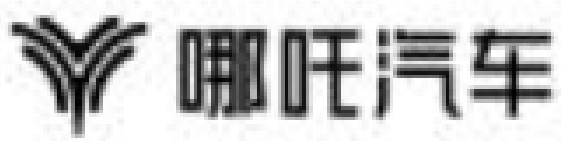


苏州研发制造中心




北京研发中心

服务客户



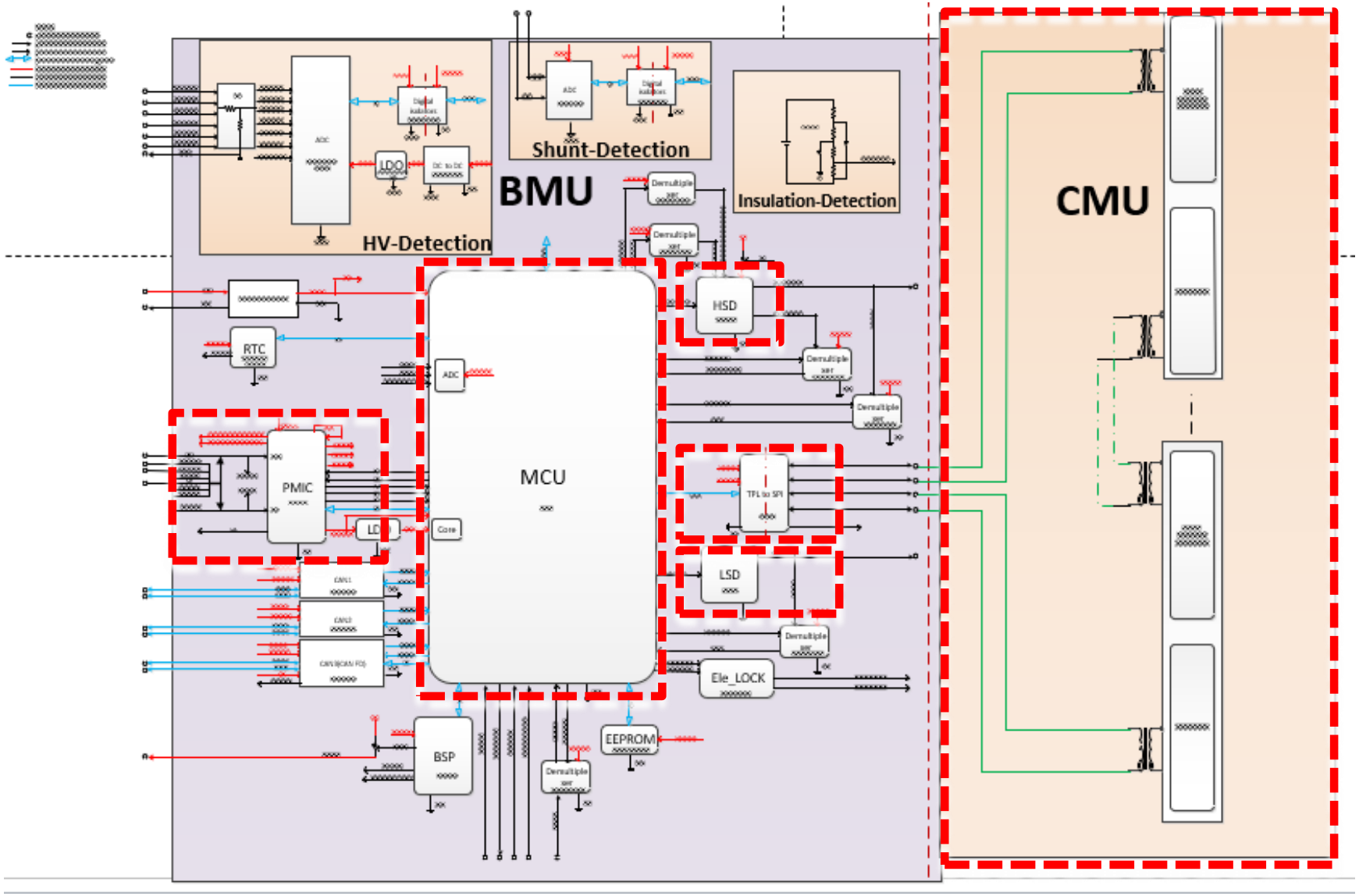
搭载哪吒V&U车型BMS方案介绍

哪吒V (2021)

哪吒U Pro (2021)

主芯片	**INF TC277**	
电源管理	**INF TLF35584**	
高压采样	TI ADS7951	
模拟前端&电平转换芯片	**INF TLE9012&TLE9015**	
绝缘检测	平衡桥（2开关）	
继电器驱动	**INF BTS724G** **BSP78**	
CAN通信	NXP TJA1044 TJA1145	
高压互锁	PWM	
电流采集	模拟量霍尔+CAN通信霍尔	

搭载哪吒V&U车型BMS方案介绍

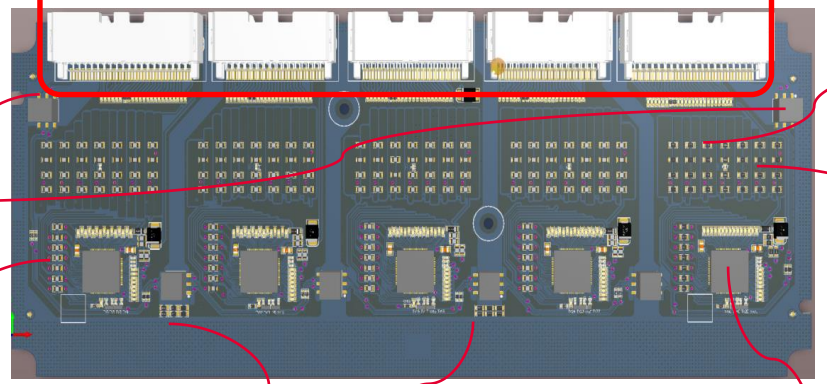


TLE9012资源优势

主流AFE部份参数对比				
品牌	Infineon	ADI	NXP	TI
参数	TLE9012	ADBMS6815M	MC33771C	BQ79616
采集串数	2~12	4~12	7~14	6~16
单体采集	±1.5mV@0~2V **±2.1mV@2.5~3.6V** **±2.5mV@3.6~4.3V** **(-40℃~125℃)**	±1.4mV@0~2V ±2.2mV@2~3.3V ±2.8mV@3.3~4.5V (-40℃~125℃)	±1.5mV@0~1.5V ±2.0mV@1.5~3.7V ±2.8mV@3.7~4.3V ±4.5mV@1.5~4.5V (-40℃~125℃)	±2mV@2~4.5V(-20℃~65℃) ±3mV@0~5V(-40℃~105℃)
模组采集	**支持，典型值** **±0.05%** **最大误差±0.5%**	支持，典型值 ±0.05% 最大误差±0.5%	支持 最大误差±0.5%	支持，典型值±200mV
负压采集	**所有12个通道最大-1.9V**	不支持	不支持	**所有16个通道最大支持-2V** **单独busbar通道**
内部均衡	**200mA@Mosfet/2.6Ω**	**300mA@Mosfet/1Ω**	**300mA@Mosfet/0.8Ω**	240mA@Mosfet/2.5Ω
通讯方式	**UART/Daisy Chain** **Transformer or Cap**	SPI/Daisy Chain Transformer or Cap	SPI/Daisy Chain Transformer only	Daisy Chain Transformer or Cap

搭载哪吒V&U车型BMS从板硬件架构

BMS从板



接插件卡扣防呆，颜色防呆，降低装配工艺要求

双向菊花链，兼容多个CMU跨电压平台设计；防止线束异常，保证通信无忧；增加通信速率，增加单体数据实时性；

ΔT仅为20℃低温升均衡，最大电流可达300mA

正反面均衡温度检测，均衡异常检测；

单个AFE分布5路温度采集，可实时均匀检测模组温度，增加温度检测可靠性；

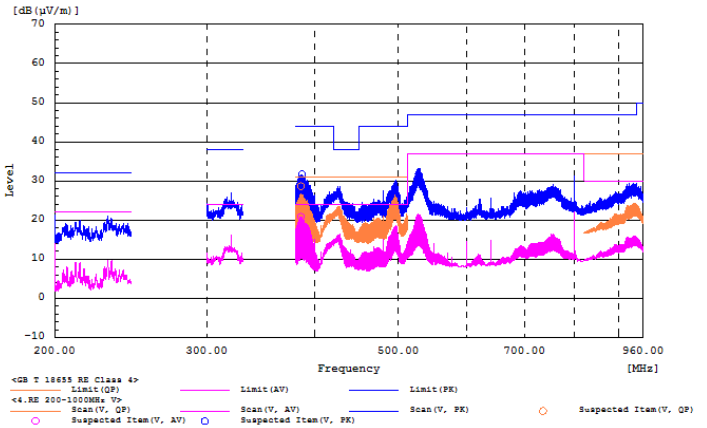
2个选贴配置，实现CMU成本最优化设计；

英飞凌AFE TLE9012芯片，12路电芯电压&5路温度采集，断线检测、超低功耗监控电芯电压&温度

BMS开发过程介绍-EMC测试

序号	试验项目	试验标准	试验方法	通过标准	测试结果
1	辐射发射	CISPR 25	BMS工作模式：运行模式 测量BMS的辐射值	**等级4**	通过
2	电源线传导发射	CISPR 25	BMS工作模式：运行模式 测量BMS对供电电源正极的辐射值	**等级4**	通过
3	控制/信号线传导发射	CISPR 25	BMS工作模式：运行模式 将除电源以外的所有信号线捆扎在一起，测量信号线的辐射值	**等级4**	通过
4	瞬态传导发射	ISO 7637-2	BMS工作模式：运行模式 试验按照快脉冲模式，及电源开关安装在靠近BMS一侧 记录BMS关闭瞬间、激活瞬间、连续工作三种模式下电源线的电压波形图，并记录最大正幅度和最大负幅度	正的慢充峰值限值为50V 正的快充峰值限值为75V 负的慢脉冲峰值限值为-75V 负的快脉冲峰值限值为-112V	通过
5	发射机抗扰	ISO 11452-9	BMS工作模式：运行模式 干扰强度按照ISO标准	Ⅰ级	通过
6	BCI抗扰	ISO 11452-1 ISO 11452-4	BMS工作模式：运行模式 干扰频段：0~400MHz扫频 干扰电流：**200mA**	Ⅰ级	通过
7	自由场抗扰	ISO 11452-2	BMS工作模式：运行模式 干扰信号：频带80~2000MHz，100V/m	Ⅰ级	通过
8	低频磁场抗扰	ISO 11452-8	工作模式：运行模式 干扰信号：频带15Hz~1000Hz，强度300 A/m 频带1kHz~10kHz，强度300/f² A/m 频带10kHz~150kHz，强度3A/m	Ⅰ级	通过
9	电源线瞬态传导抗扰	ISO 7637-2	工作模式：运行模式 测试脉冲：脉冲1、脉冲2a、脉冲2b、脉冲3a、脉冲3b、脉冲4、脉冲5	Ⅰ级	通过
10	控制/信号线瞬态传导抗扰	ISO 7637-3	工作模式：运行模式 测试脉冲：慢脉冲a（5min）、慢脉冲b（5min）、快脉冲a（10min）、快脉冲b（10min）。	Ⅰ级	通过
11	静电放电	ISO 10605	工作模式：运行模式 放电强度：接触放电±4kV、±6kV、±8kV 空气放电±6kV、±8kV、±15kV、±25kV 每个测试电压，测量次数应不少于3次。两次测试之间的时间间隔应不少于1s。	脉冲L1:Ⅰ 脉冲L2:Ⅰ 脉冲L3:Ⅱ 脉冲L4:Ⅱ	通过

EMC RE测试设置



EMC RE测试结果

BMS开发过程介绍-装包测试

哪吒V电池包

哪吒U电池包

服务客户 合作共赢

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