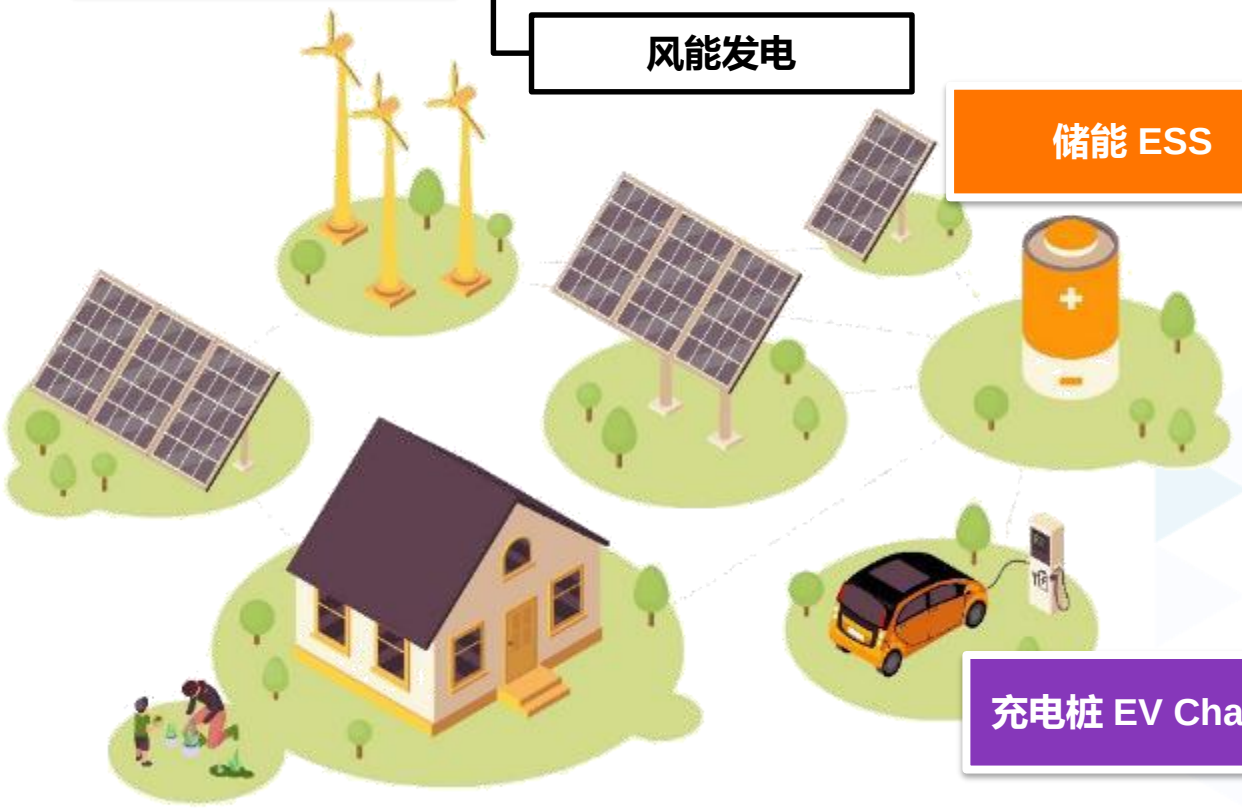
ADI 针对储能系统的电池管理产品及系统设计

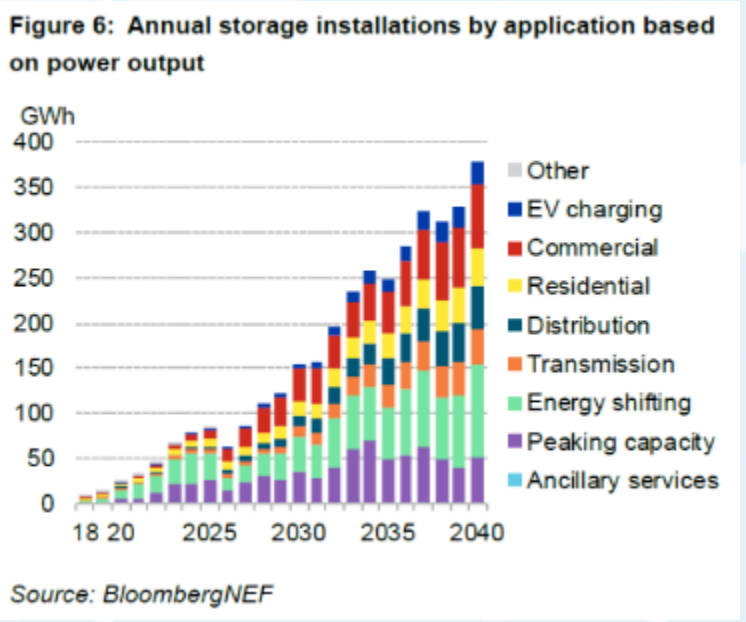
议 程

- 储能系统及市场
  - 储能市场趋势—越来越多的锂电池
  - 储能与新能源
- 用于储能及电池管理（BMS）的芯片技术
  - 锂电池精确测量的重要性
  - ADI的高精度BMS芯片
  - 用于BMS系统的可靠的隔离通信 -- IsoSPI
  - 库仑计和主动均衡芯片
  - 基于功能安全的BMS设计
  - ADI的无线网络技术
- 储能系统中的电池管理系统结构
  - 用于储能的BMS系统结构
  - ADI 评估板及系统方案
  - ADI网站的设计资源
- 储能用于充电站建设及功率转换
- 功率转换系统设计

新能源领域的几个重要市场趋势

- **可再生能源发电**
  - 1500V 工业光伏逆变
  - >1000V 户用光伏逆变
  - 风能发电
- **储能 ESS**
  - 1500V, >50kWh 电网侧储能
  - >1000V, >5kWh 户用储能 ESS
  - 通讯基站和数据中心用 UPS/ESS
- **充电桩 EV Charger**
  - >1000V 直流充电桩
  - >10kW 无线充电
  - 充电基础设施建设





ADI 能源解决方案 – 储能和充电桩

储能系统
ESS

- 电化学电池的电池管理BMS
- 功能安全
- 充电系统

- 短距离无线通信
- 工业以太网

连接与通信

例：基于ESS的
大功率直流充电

能源和
电池管理

- “云”解决方案

- 交流电表 AC Meter
- 直流电表 DC Meter
- 断路器Circuit Breaker

计量、测量和
保护

大功率逆变

- 1500V SiC的隔离门驱
- 电源设计

储能系统及应用

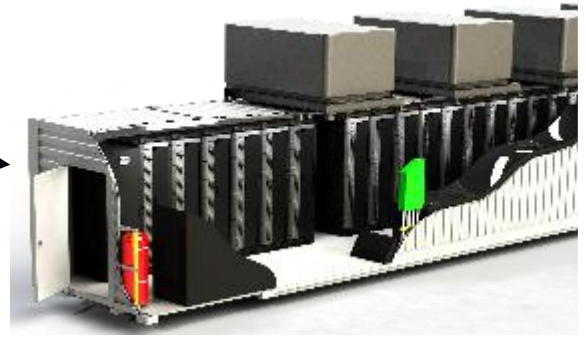
工业应用

储能

风、光与储能结合

充电站

家用储能



电网侧储能系统

储能系统 – 越来越多的锂离子电池

锂电池储能系统的特点

- 锂离子技术具有高电池电压
  (三元锂: 3.6~3.7 V; 磷酸铁锂:3.1~3.2V)
- 相应的高能量密度
- 基于磷酸铁锂(LiFePO4)的电池本质上更安全
- 通常内置于多单元模块中，堆叠方式
- 由电池管理系统控制
- 锂离子电池的安全特性
  - 由系统设计来决定（结构设计、热设计等）

锂离子电池的特点

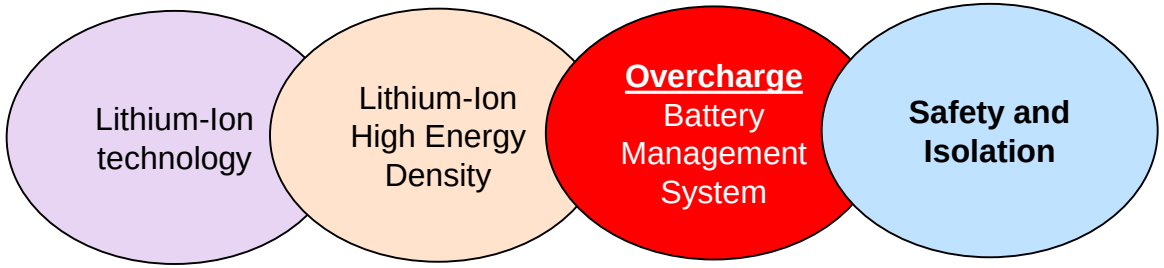
- 锂离子电池缺乏耗散过充能量的能力
  - 欠压/过压保护
  - 充放电保护
- 锂离子电池容量随时间变化
  - 需要<5% 被动均衡 (<200 mA)
  - 需要 >5% 主动均衡(10 A或更大)

BMS (电池管理系统) 的核心

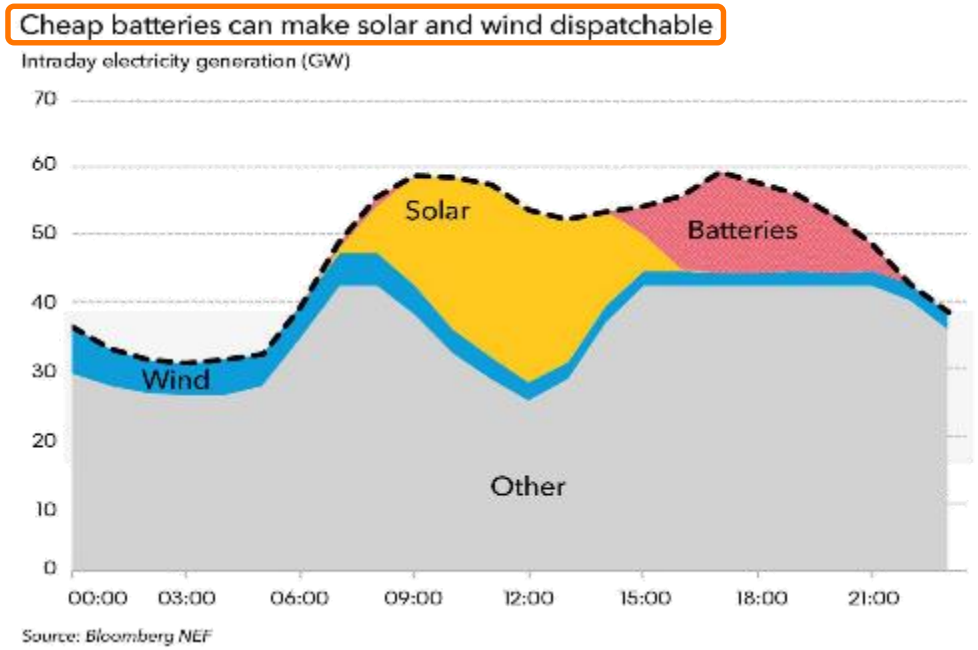
- 确定荷电状态(SOC)
- 测定电池健康状况（SOH）
- 均衡
- 安全及保护：过压/欠压检测

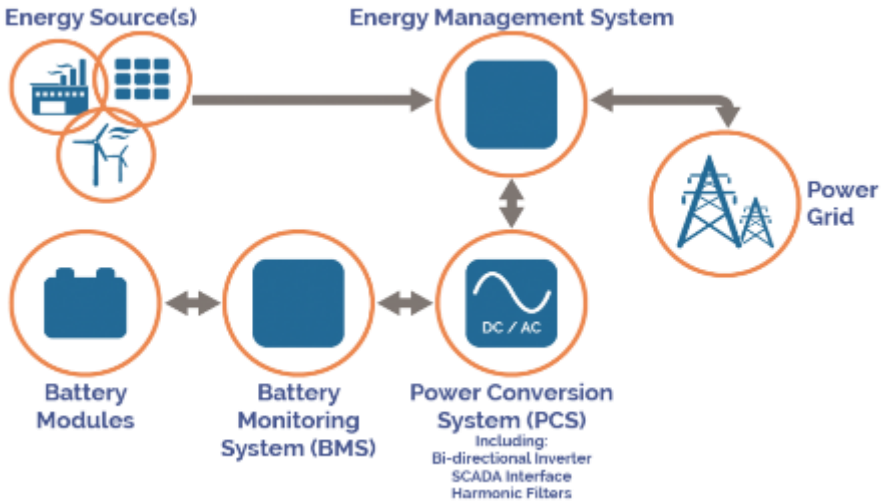
储能系统和新能源

- 新技术驱动储能及新能源市场
  - 电池管理
  - 功率转换



- **ADI的电池管理系统 (BMS)**
  - 电池管理系统可以通过监测和均衡电池来最大化电池容量
  - 多通道电池管理 (6, 12, 15, 18)
  - 菊花链设计让系统更简洁
  - 隔离通信 (2 线, 2M速率)
  - 功能安全诊断及系统级设计
- **ADI的功率转换系统 (PCS)**
  - 系统级解决方案
  - 针对光伏和直流充电的隔离栅极驱动SiC/IGBT/Si MOSFET 方案
  - 隔离通信方案，包括 CAN, USB, RS-485 SPI
  - 电动汽车的快充系统级解决方案





用于储能及电池管理（BMS）的芯片技术

锂电池BMS：精确测量的重要性

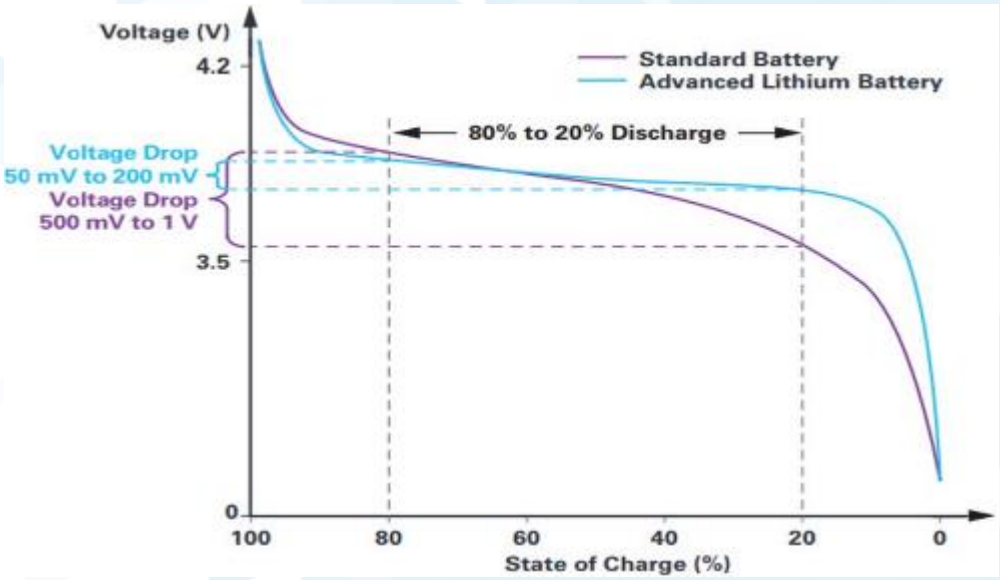
参考: *Higher Reliability, Safety, and 30% Longer Lifetime with Advanced Battery Management in Healthcare Energy Storage Systems*

精确测量的重要性

- 精度是BMS的一个重要特性，对于LiFePO4电池至关重要。为了防止过度充电和放电，电池单元应保持在满容量的10%到90%之间。如果测量误差为5%，为了继续安全地进行电池运行，必须将电池容量保持在15%至85%之间。总可用容量已从80%减少到了70%。如果将精度提高到1%（对于LiFePO4电池，1 mV的测量误差相当于1%的SOC误差），那么电池现在可以在满容量的11%到89%之间运行，增加了8%。使用相同的电池和精度更高的BMS，可以增加每次充电的电量，延长电池使用寿命。
- 电路设计人员根据数据手册中的规格来估算电池测量电路的精度。其他现实世界的效应通常会在测量误差中占主导地位。影响测量精度的因素包括：
  - 初始容差
  - 温度漂移
  - 长期漂移
  - 湿度
  - PCB装配应力
  - 噪声抑制

- SoC: 荷电状态
- SoH: 健康状态

LiFePO4 放电曲线



高精度的 SOC & SOH 信息

- 避免过冲和过放条件
  - 快速耗尽电池;尽量减少短路、火灾和其他危险情况的发生
  - 有助于使用电池中的所有能量
  - 能够以最好、最有效的方式给电池充电

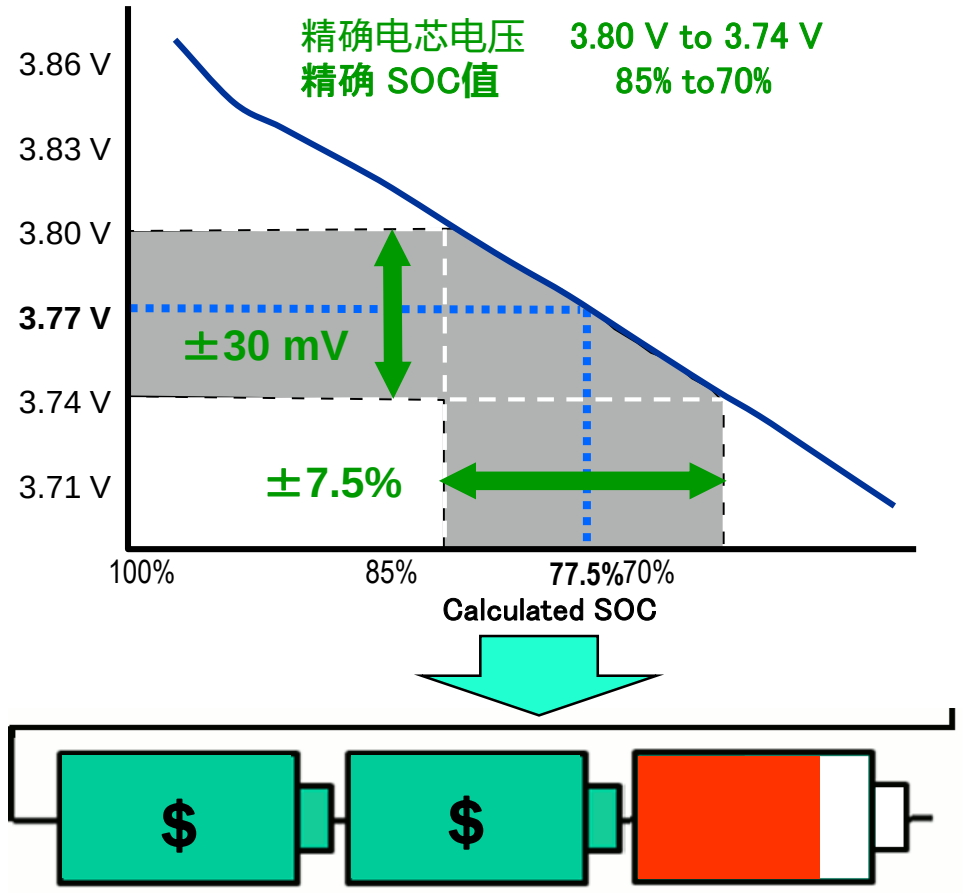
精确可靠的SOC和SOH计算

- 在最好的情况下，帮助延长电池寿命10年以上，一般可达到增加30%的使用寿命.

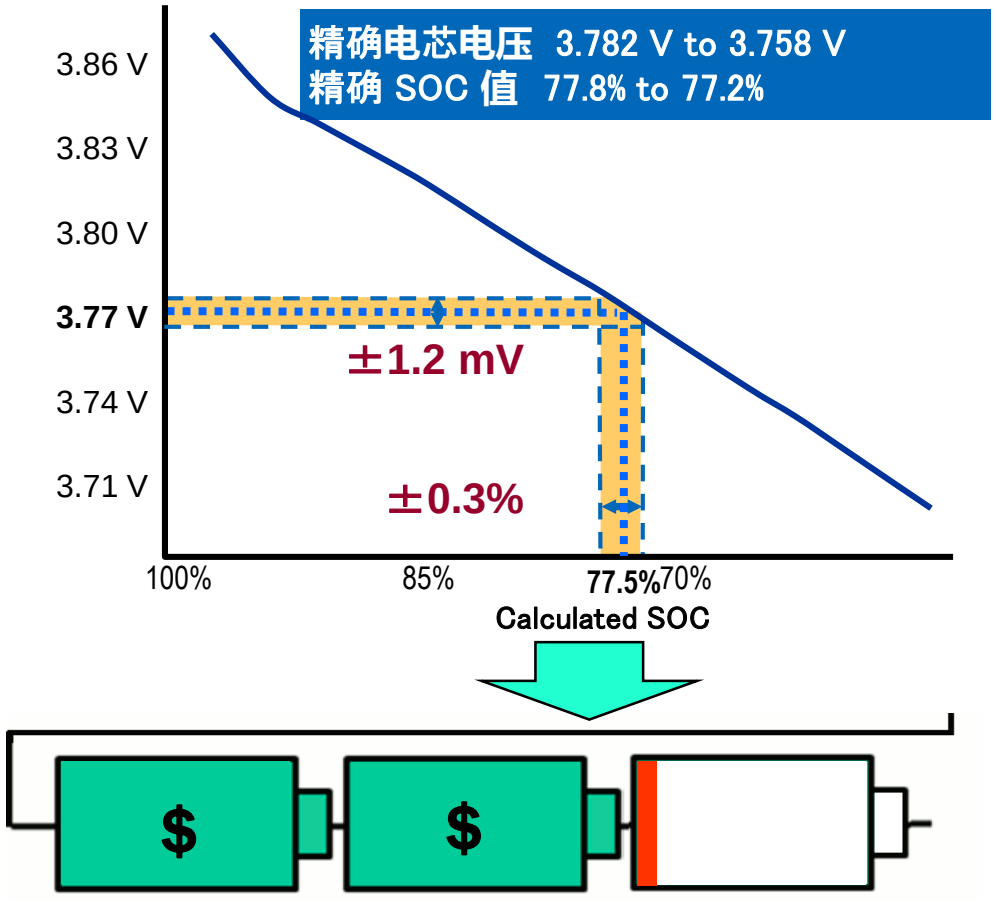
精确测量锂电池影响SoC

例子: 电芯电压值 = 3.77 V　SOC测量值 = 77.5%

如果测量误差 ±30 mV (± 7.5%)



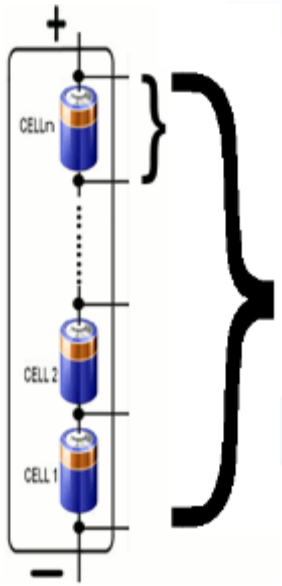
用 LTC6804 测量



降低电池成本，减轻重量，提高寿命

BMS芯片 -- 电池堆栈管理器的任务

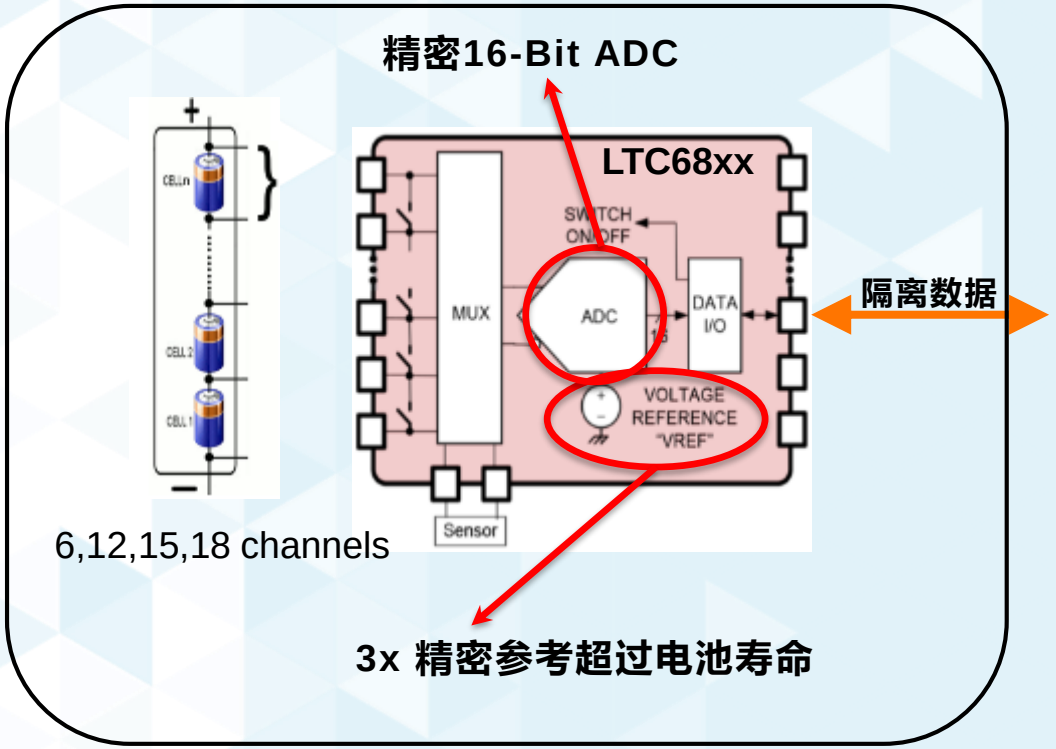
- 准确测量电池电压及其他信号
  - 给出荷电状态 (SOC) 所需确定值
  - 给出健康状态(SOH) 所需确定值
  - 实现精确的热管理
  - 精确和时间同步电流测量
  - 精确监控栈电压
  - 主动监控电池隔离
- 连续确认操作正确
  - 故障检测，确保安全运行
- 提供灵活的隔离通信体系结构
  - 启用模块化电池包（PACK）设计
  - 确保可靠的通信
- 电芯均衡(被动或主动)
  - 启用荷电状态(SOC)管理



电池堆栈管理

我们的首要任务是:

安全、可靠、准确



- ***ADI的BMS芯片内置高精度A/D转换器，结合最精确的电压基准，使更安全，更小，更低成本的电池系统有更长的寿命。ADI的隔离通信简化了电池包设计并提高了可靠性***

ADI的LTC68xx系列内置高精度ADC

FEATURES

- Pin-Compatible Upgrade from the LTC6804
- Measures Up to 12 Battery Cells in Series
- **1.2mV Maximum Total Measurement Error**
- Stackable Architecture Supports 100s of Cells
- Built-in isoSPI™ Interface
  - 1Mb Isolated Serial Communications
  - Uses a Single Twisted Pair, up to 100 Meters
  - Low EMI Susceptibility and Emissions
- 290µs to Measure All Cells in a System
- Synchronized Voltage and Current Measurement
- **16-Bit Delta-Sigma ADC with Programmable 3rd Order Noise Filter**
- Engineered for ISO 26262-Compliant Systems
- Passive Cell Balancing with Programmable Timer
- 5 General Purpose Digital I/O or Analog Inputs
  - Temperature or other Sensor Inputs
  - Configurable as an I^2C or SPI master
- 4µA Sleep Mode Supply Current

来自LTC6811 数据手册

ADC的精度对精确计算电池的真实SoC非常重要.

测量误差

- LTC6811: **±1.2 mV (最大) 16-Bit** (ΔΣ)
- 竞争者: ±2 mV (典型值), 14-Bit (SAR)

* SOC: 荷电状态

ADI BMS芯片 – 多单元电池堆栈管理和均衡

Part #	Channels	Charge Current (A)	Vin Range (v)	Direction	Package	Main Feature
Stack Monitors \ Balancers						
LTC6801	12		60		36 SSOP	1% error, 15.5ms cell measurement time
LTC6802-2	12	0.1	60	Discharge	44 SSOP	
LTC6803 -2\-3\-4	12	0.1	75	Discharge	44 SSOP	13ms to measure all cells
LTC6804 -1\-2	12	0.2	75	Discharge	48 SSOP	290µs \Daisy chain \ addressable (4 bit) \IsoSPI
LTC6810	6	0.15		Discharge		Dual Cell measurement(ea. ch) \ IsoSPI
LTC6811 -1\-2	12	0.05	75	Discharge	48 SSOP	Daisy chain \ addressable (4 bit)\ IsoSPI\ 1.2mV \ 2x ADC \ 3x Filt
LTC6812	15	0.2				14 Cells @4.2V = 58.8 (<60V) , easier to Certify
LTC6813	18	0.15	112.5	Discharge	64 LQFP	IsoSPI \ 290µs \ 2.2mV \ 3xADC's \ 4x Filt. \
ADBMS6815/17 (New)	12/8	0.3			48 LQFP	IsoSPI \ 2.2mV \ 7xADCs
ADBMS1818 (New)	18	0.2	112.5		64 LQFP	IsoSPI \ 3mV \ 9xGPIO for Temp
AD7284	8	--	40	--	64 LQFP	16mV cell accuracy, 14 bit ADC, Auto Qual
AD8280	6	--	30	--	48 LQFP	Analog\HW only, Backup Monitor,Industrial
Cell Balancers						
LTC3305	4	10	64	Discharge	38 TSSOP	Lead Acid Battery balancer
LTC3300-1\-2	6	2.5\10	36	Charge & Discharge	48QFN	Bi-directional, Daisy Chain\addressable
LT8584	1	2.5	7.5	Discharge	16 TSSOP	Li-ion

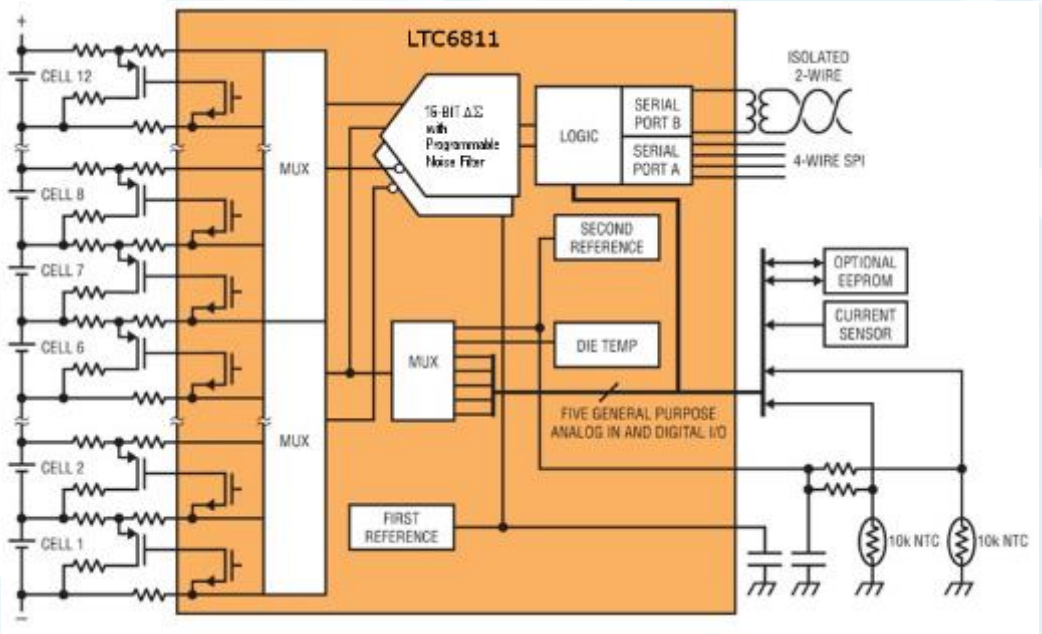
LTC6811 – 12电芯，可堆叠电池管理

产品特色

- Measures 12 Series Connected Battery Cells
- Industry Leading Accuracy:
  - < 1.2mV Total Measurement Error @ 25°C
  - < 2.2mV Total Measurement Error -40°C to 125°C
- 16-Bit Delta Sigma
  - 8 Programmable Oversampling Ratios / Noise Filter Settings
    (26Hz, 422Hz, 845Hz, 1.7kHz, 3.4KHz, 6.8kHz, 13.7kHz, 27kHz)
- Built-In isoSPI™ Interface:
  - Uses a Single Twisted Pair
  - 1Mb Isolated Serial Communications
  - Passes 200mA BCI testing
  - Supports Random Stackability
- Active and Passive Cell Balancing Control
- 5 General Use Digital I/O or Analog Inputs
- Synchronized Voltage and Current Measurement
- 4µA Sleep Mode Supply Current

Safety and Reliability Features

- Tolerates Voltages Up to 75V
- Fully Specified from -40°C to 125°C
- Includes Comprehensive Self Tests
- Engineered for ISO26262 Systems



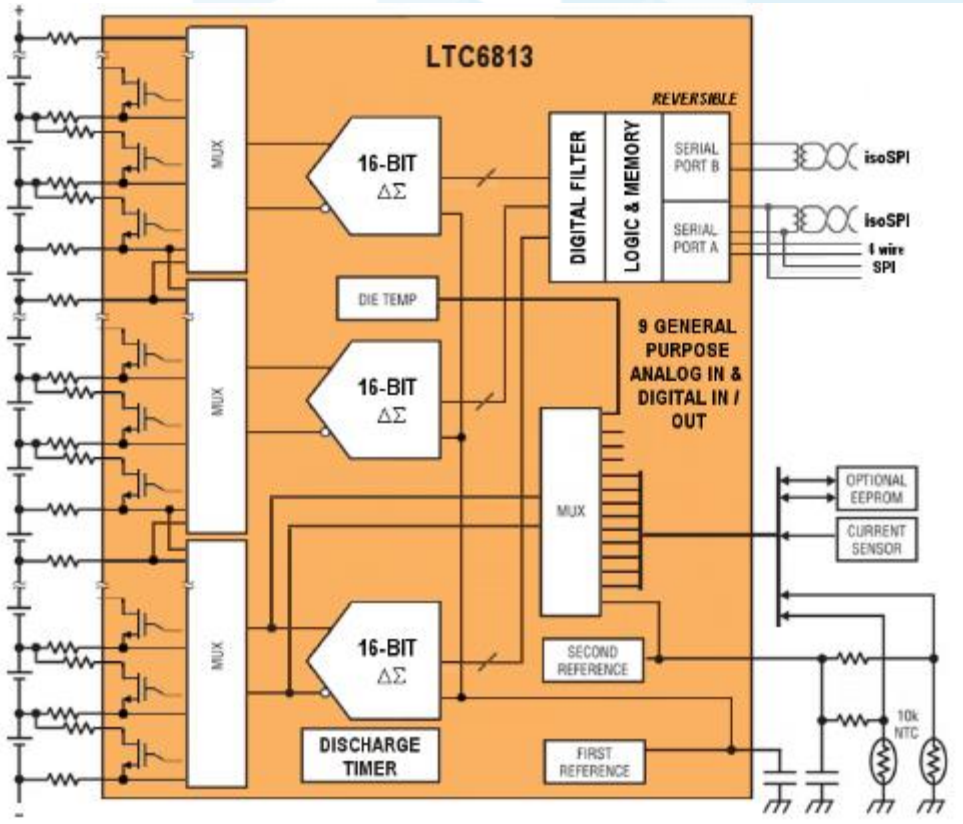
LTC6812 & LTC6813 -- 15 & 18 电芯电池管理

基于 LTC6811 设计

- 与LTC6811相似的规格
- LTC6811具有相同的基本特性

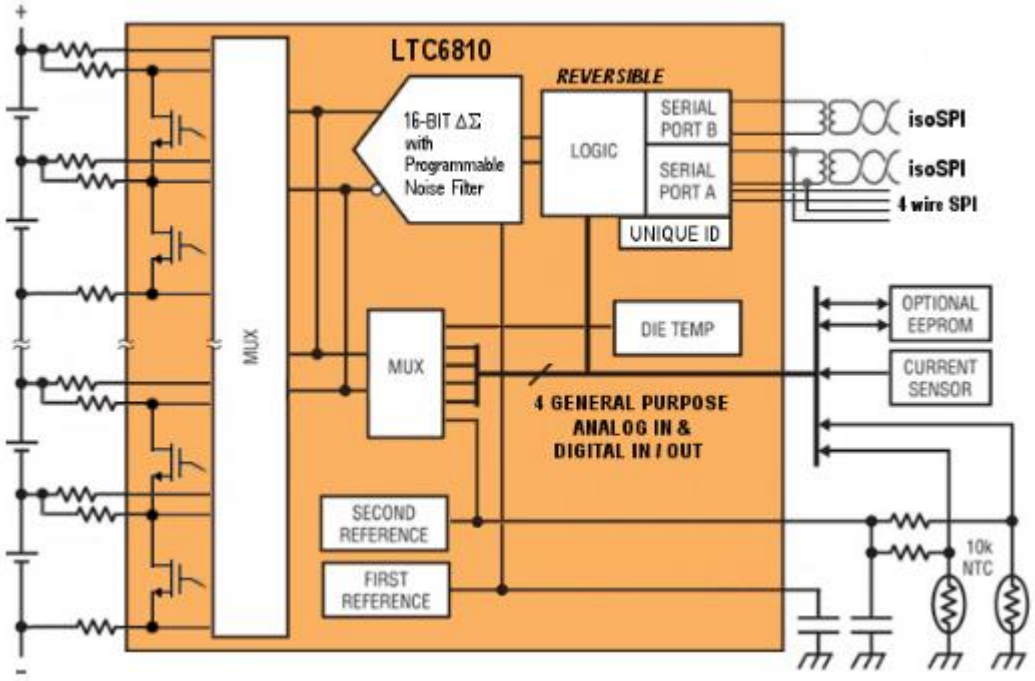
独特的功能

- Reversible isoSPI
- 被动均衡可达200mA
- 9个通用Analog In & Digital I/O
  - Includes Open Wire Detection
- LQFP 64pin 封装



业界单芯片可支持最多的电压测量通道（18-）

LTC6810 -- 6 电芯电池管理



Ideal for Large Cell Modular Designs

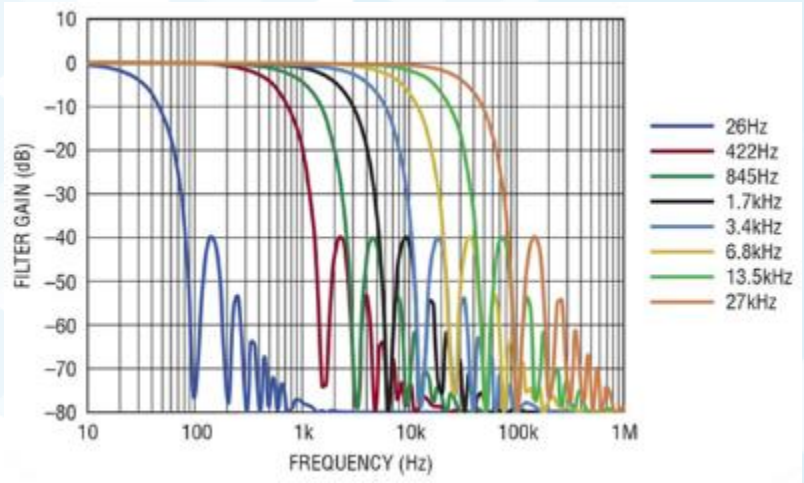
独特的设计

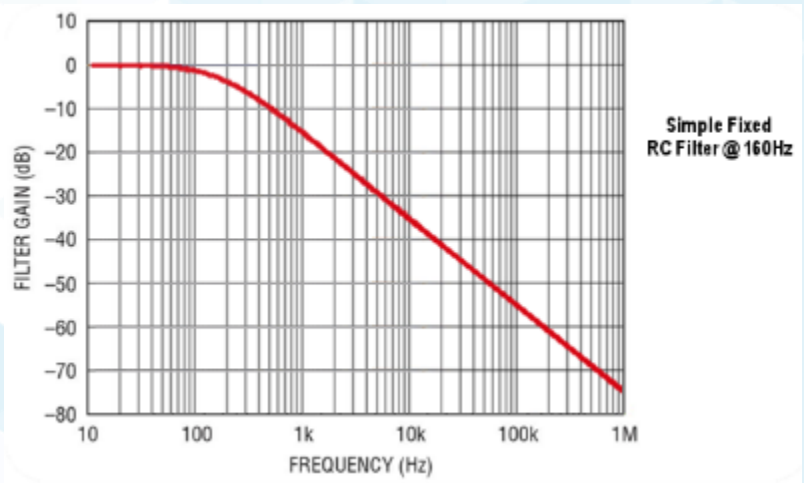
- Measures 6 Series Connected Cells
- Includes Dual Cell Measurement Capability (Fault Coverage)
- Includes Reversible isoSPI
- 150mA Passive Cell Balancing Capability
- 4 General Use Digital I/O or Analog Inputs
- Ability to Operate in 7-Cell Mode
- Operates with Stack Voltages Down to 4.8V
- Unique ID & Authentication Feature

LTC681x内置ADC噪声滤波器可减少测量误差

- **噪声滤波, 16-Bit Delta Sigma**
  - 8个可编程的过采样比率/噪声滤波器设置(26Hz到27kHz)
  - 旨在消除10kHz逆变器噪声，电机噪声，瞬变和射频干扰

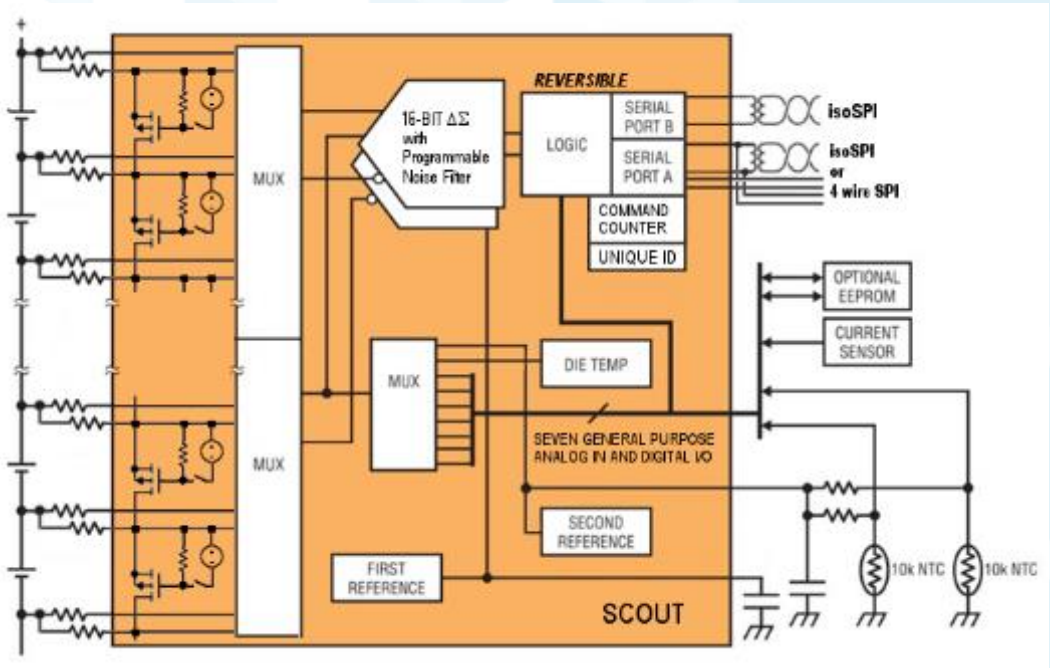
- **Delta Sigma 优势**
  - 减少对昂贵的前端RC滤波器的依赖
  - 更好地抑制高次谐波
  - 更好的精度
  - 多路复用器可以较慢地消除串扰、共模抑制和建立时间误差.





ADBMS6815/17 – 第五代BMS芯片

- **Measures 12/8 Series Connected Battery Cells**
- Industry Leading Accuracy:
  - < 1.2mV Total Measurement Error @ 25°C
  - < 2.2mV Total Measurement Error -40~125°C
- 16-Bit Delta Sigma
- 8 Programmable Oversampling Ratios / Noise Filter Settings
- **Advanced Reversible isoSPI™ Interface, 2Mbps**, Capacitor or Transformer Coupled
- **300mA Passive Cell Balancing Capability**
- 7 General Use Digital I/O or Analog Inputs
- Synchronized Voltage and GPIO Measurements
- 4μA Sleep Mode Supply Current
- **Fully Supports ASIL D \ SIL Systems (Detects external faults and internal faults)**
- **Tolerates Voltages Up to 85V**
- Specified from -40°C to 125°C
- **Designed to withstand hot plug of at least 96 cells**

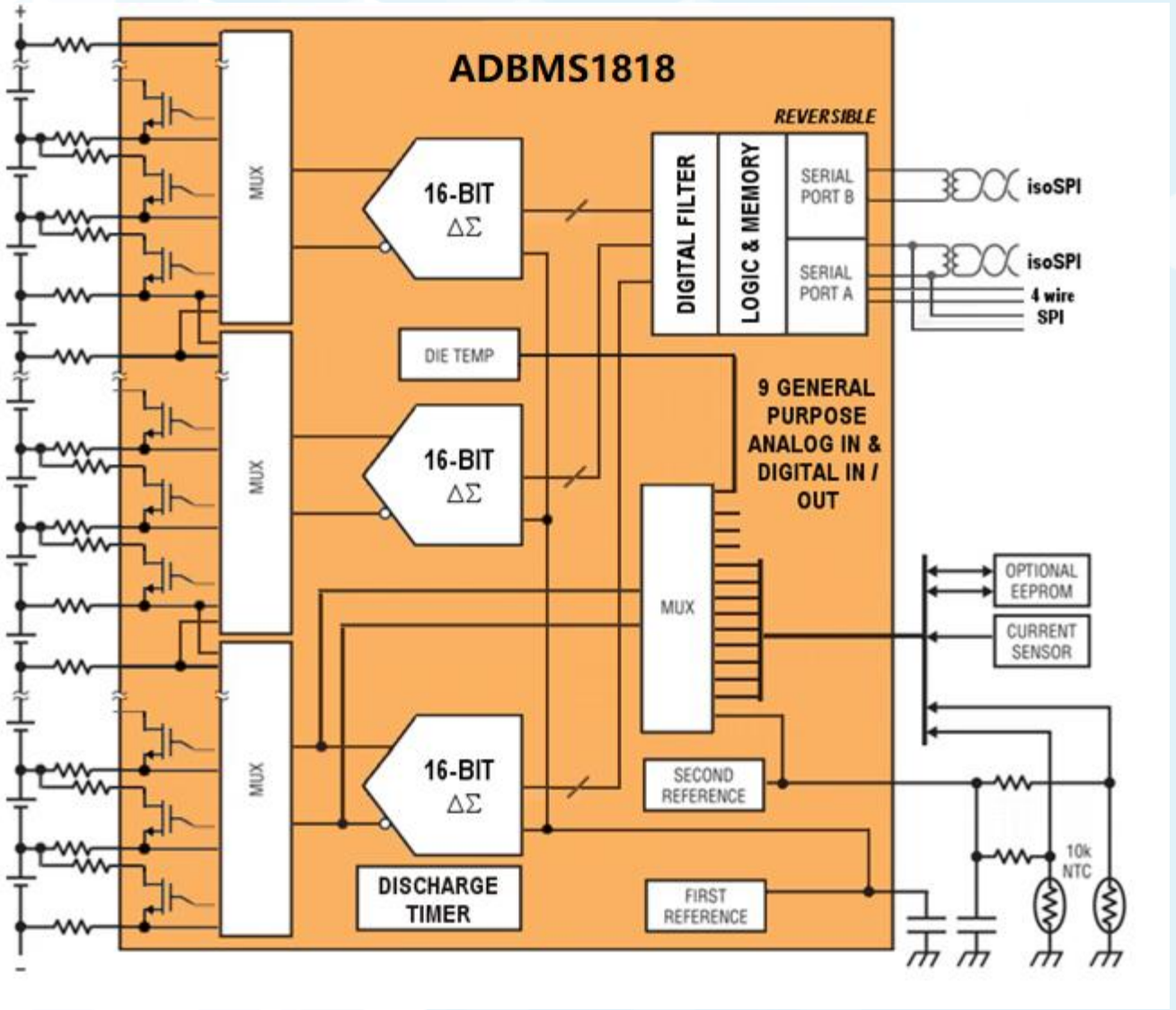


Part	ADBMS6815	
Description	12-Cell Battery Monitor	
Schedule	A-Sample	Q3 CY18
	Release	Q1 CY20

ADBMS1818 – 工业BMS芯片

主要特点

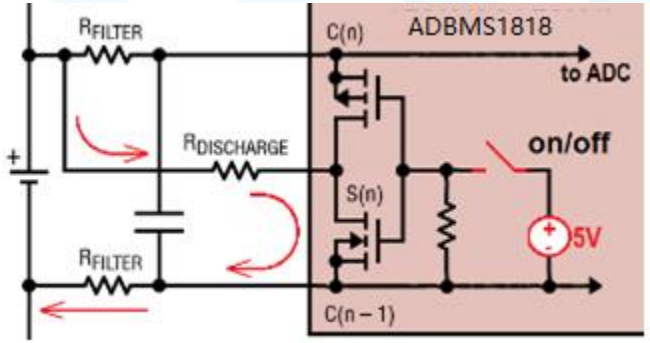
- Measures 18 Series Connected Battery Cells
- Industry Leading Accuracy:
  - 3.2mV Total Measurement Error
- 16-Bit Delta Sigma - Programmable Noise Filter
- Advanced Reversible isoSPI™ Interface
- 200mA Passive Cell Balancing Capability
- 9 General Use Digital I/O or Analog Inputs
- Synchronized Voltage and GPIO Measurements
- LQFP 64pin package

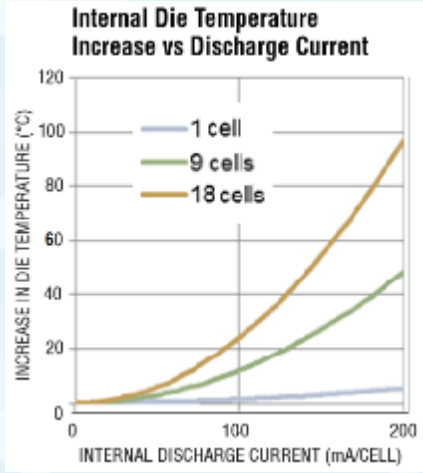


主要改进: 放电电路

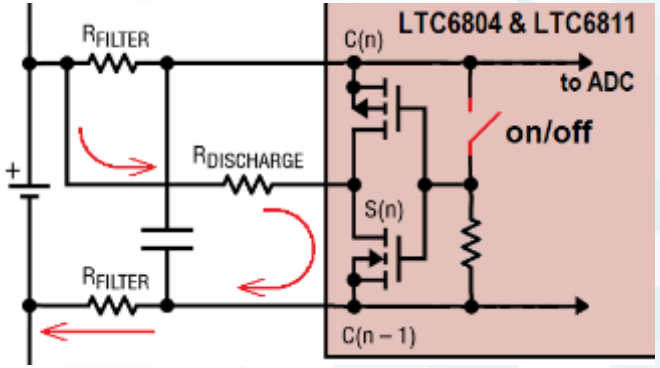
新的放电结构:

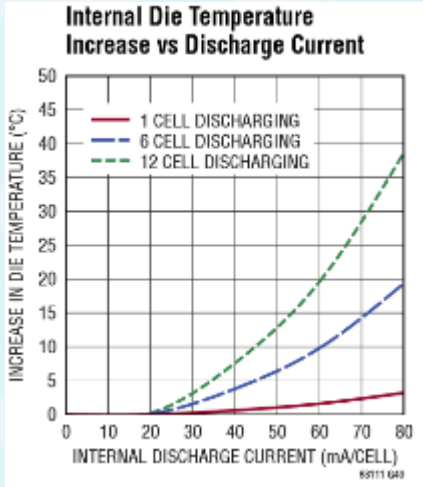
- MOS 门驱动保持5V, 独立于 Vcell
- MOS 增大可以用更低的电阻
  - 200mA 最大放电电流
  - 基于200mA最大50%占空比 对18个电芯可以有100mA 平均电流





vs.



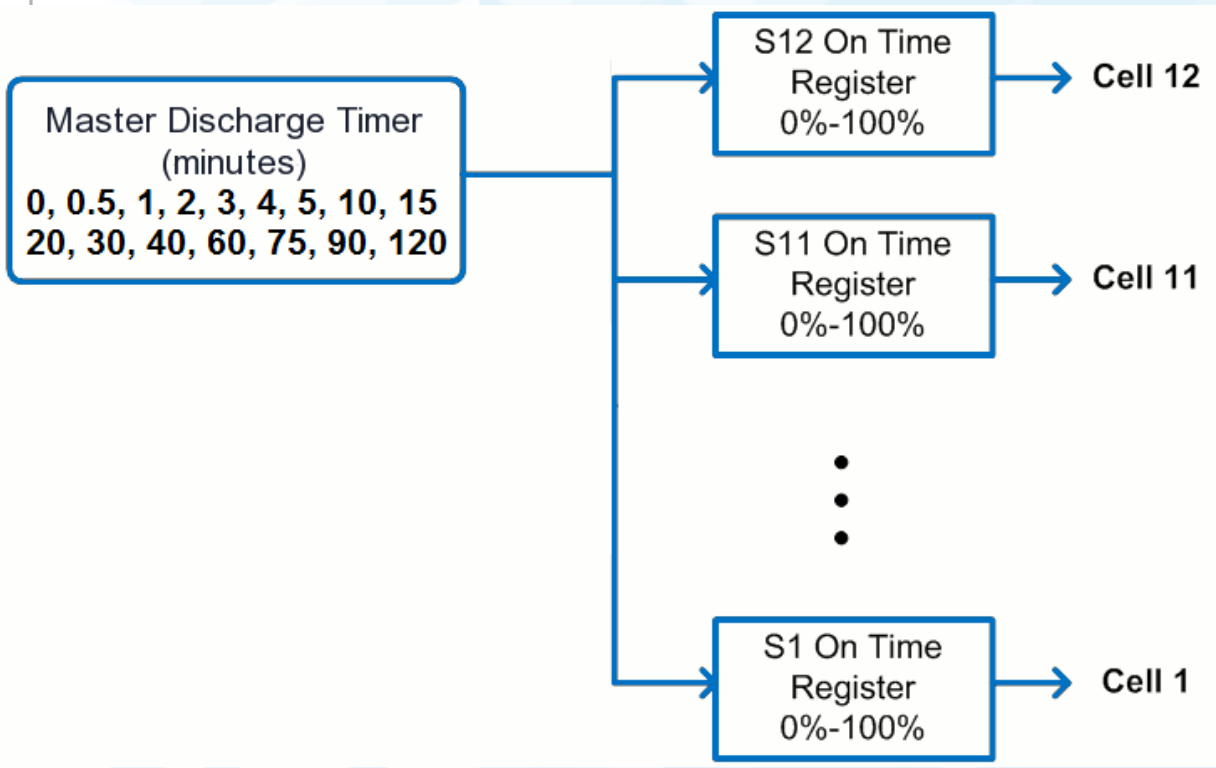


主要改进: PWM 放电控制

每个通道支持自动PWM控制

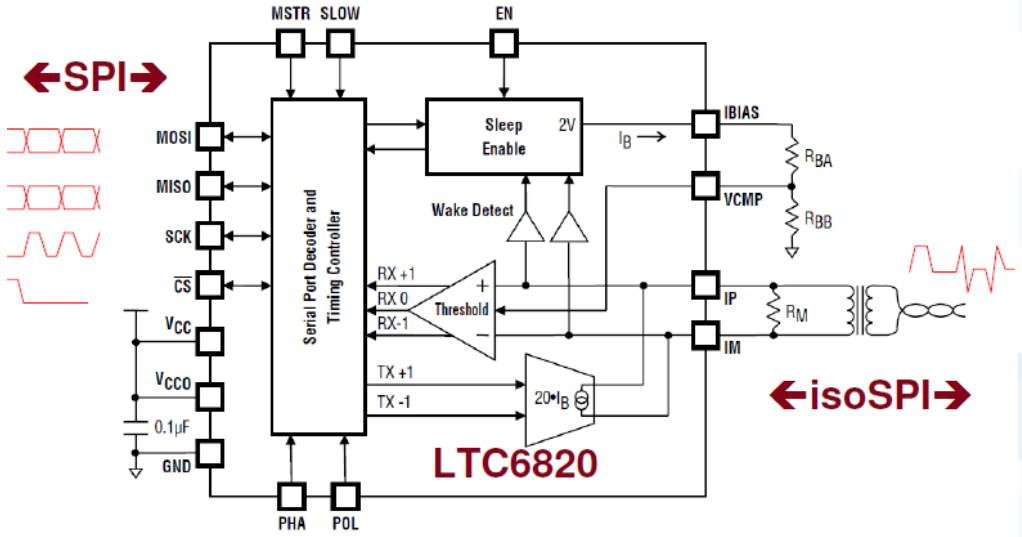
- 定时的 PWM 控制
  - 每个 S-Pin 可配置: 0% to 100% 占空比 (6.67% 调整步幅)
  - 30秒 PWM 周期
- 可在低功耗模式下操作
- 可编程持续时间
  - 直到120 分钟
- 低压和过压监控（UV & OV Monitoring）
  - 有低压标志可停止被动均衡

PWM Duty Cycle Tailors Passive Balancing for Each Cell

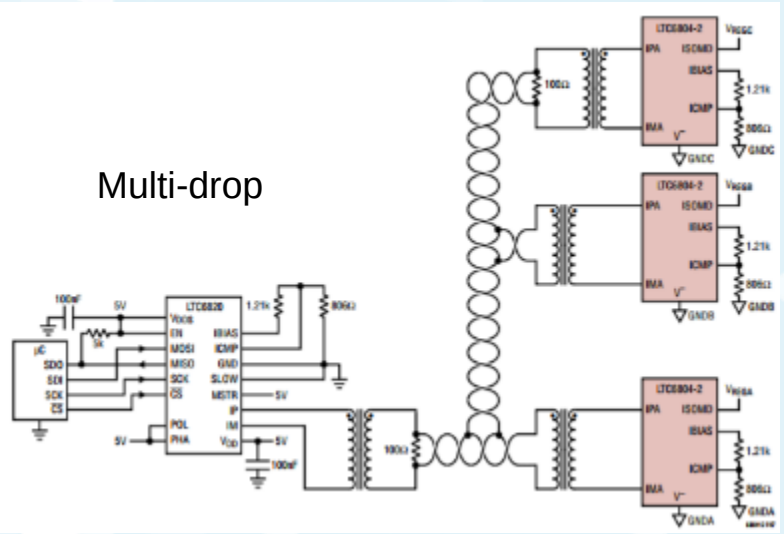


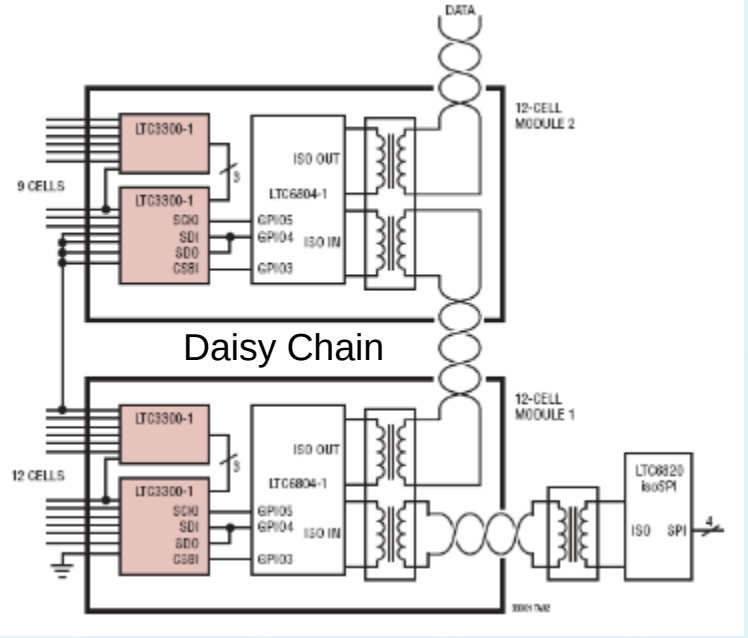
隔离通信 isoSPI ™ ： LTC6820

- isoSPI：2-线隔离数据通信
- 异步数据和芯片选择脉冲。没有时钟，没有DC内容。没有时间参考，1Mbps
- 简单, 像连接处理器的SPI
- 比CAN便宜，需要一个变压器和被动器件
- 工作在双绞线，低阻抗。通过200mA BCI(大电流注入)
- 没有缓冲或转换数据(安全)
- 对菊花链中的设备数量没有理论上的限制。实际上，已经用到了30个节点.
- 抗射频干扰
- 可以100米电缆
- 容忍断线



Multi-drop





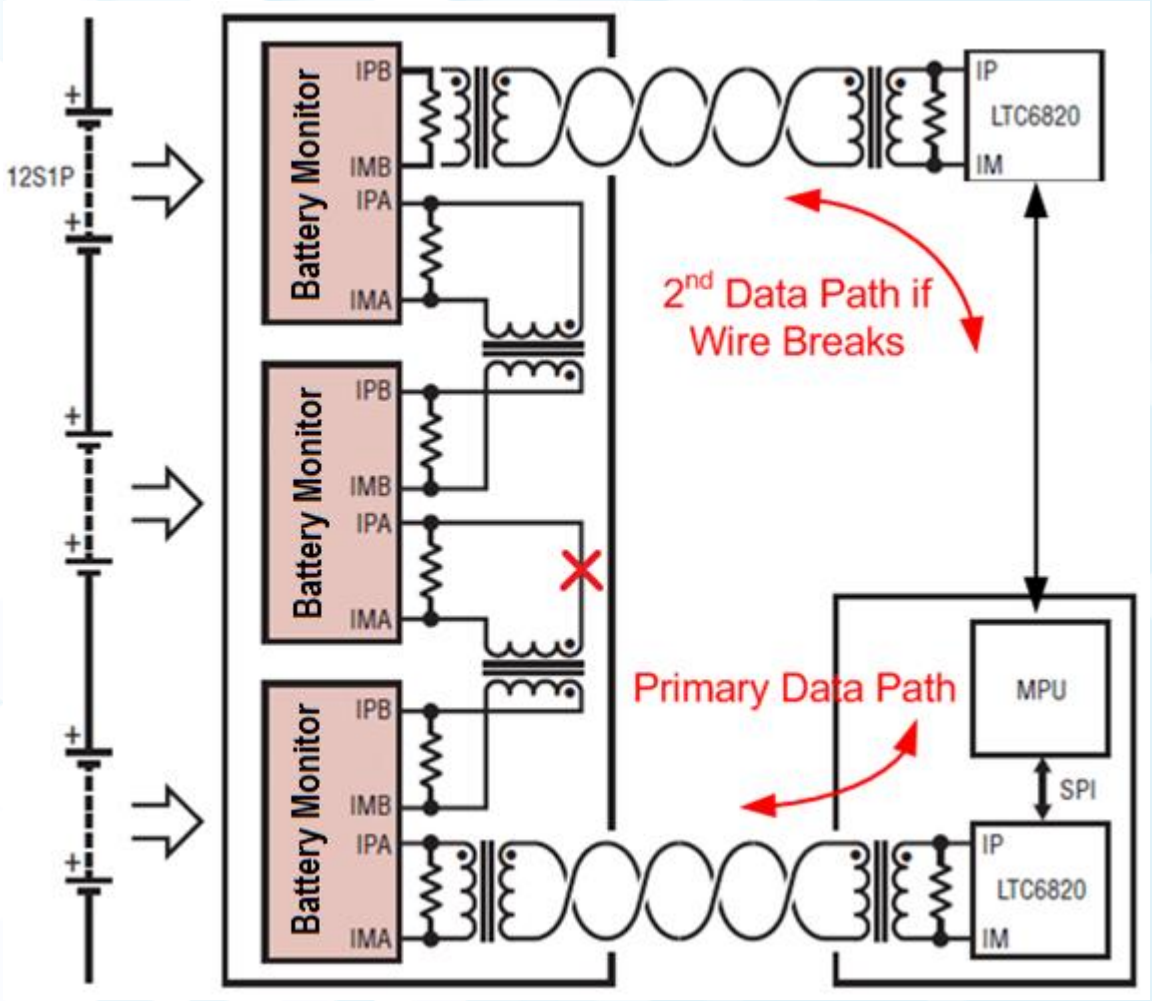
新一代BMS芯片支持双向可逆的通信方式

IsoSPI – 低费用菊花链通信结构

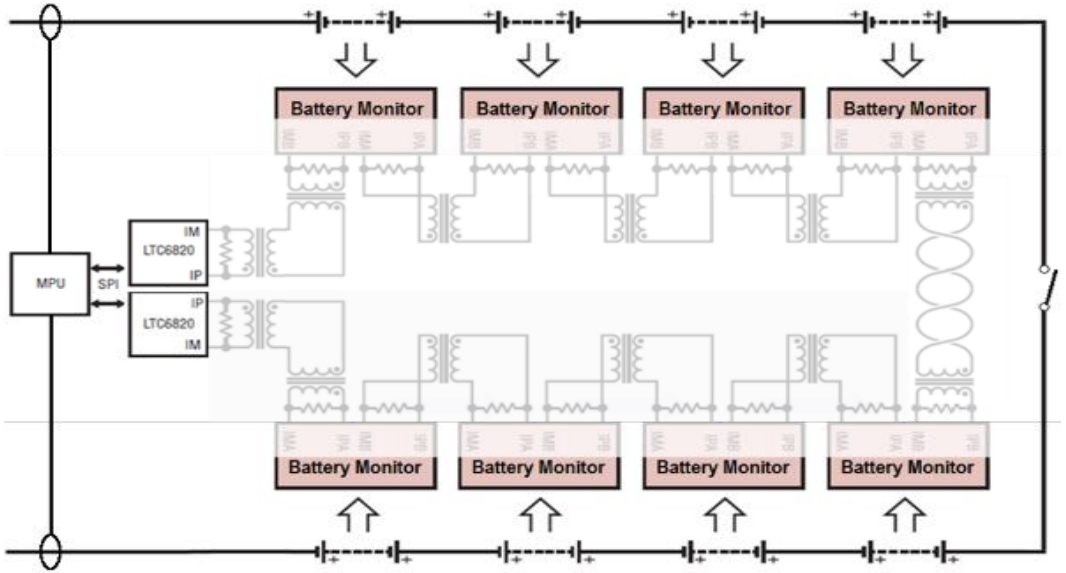
- Single Twisted Pair Only and Meters of Cable
- Capacitors or Transformer
- Bi-directional Ports: Ring Topology

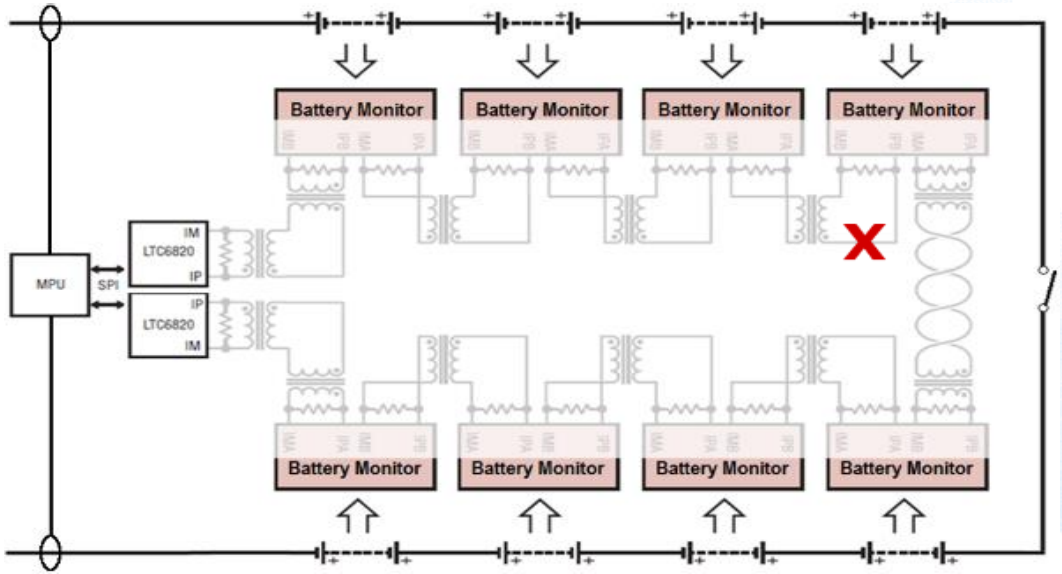
Reversible isoSPI – 双向可逆的通信

- Addresses Potential Breaks in the Daisy Chain
- Same protocol, same performance as Standard isoSPI
- Ports on each battery monitor will respond to commands
- Enables communication from 2 directions



Reversible isoSPI: 管理通信环路物理损坏





双向可逆的通信方式:

- 主控板交替使用通信端口来监控信号的完整性
- 每个端口都接受命令
- 在一个设备端口上接收到的所有命令或数据都重新发送到第二个端口
- 主机主控板持续监控通信数据
- 信号中断快速定位

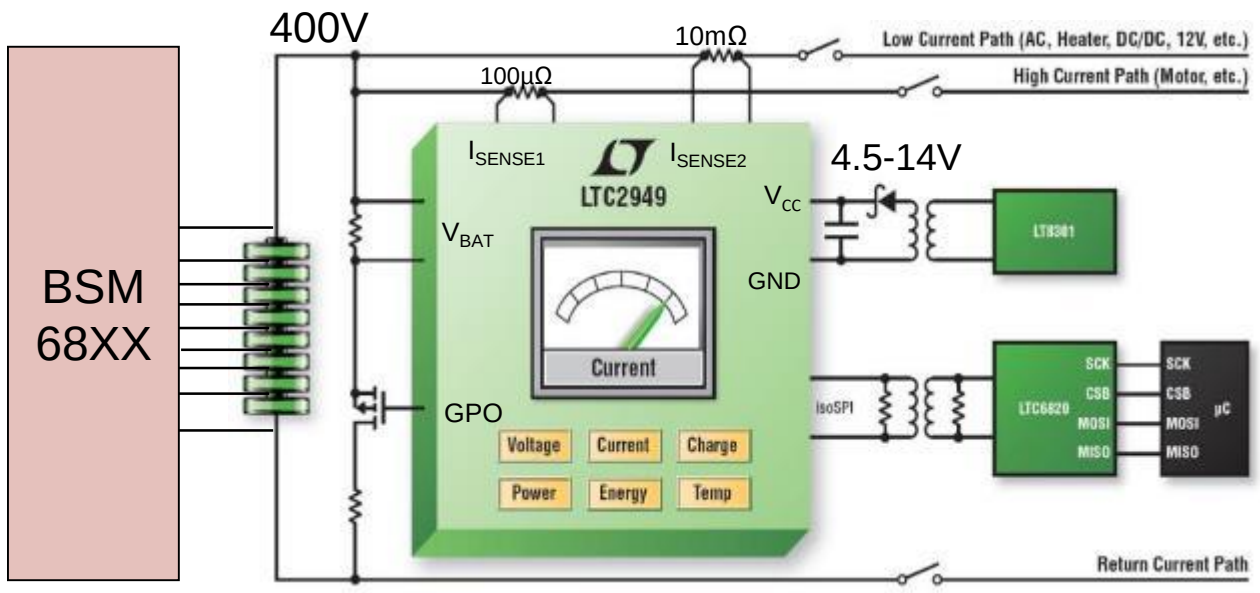
管理通信环路中物理上的损坏

- 设备在断点前收到的有效数据(经PEC确认)
- 主机在断点后接收设备的无效数据
- 主机主控板通过交流通信端口继续接收和监控所有设备

LTC2949 -- 库仑计

- **双电流测量**
  - Configurable for High Side or Low Side Operation
  - ±124mV Range, 237.5nV Resolution (20-Bit DS)
  - 3uV Offset Max (-40°C to 125°C)
  - Fast Overcurrent Detection w/ Deglitch
  - Max / Min Values Stored On-board
- **电压测量**
  - ±5.5V Range, 46µV Resolution (18-Bit DS)
  - Dedicated Stack Measurement
  - 7 Dedicated Buffered Voltage Inputs
  - 5 Additional Buffered Voltage Inputs or Digital Outputs (Configurable as Heartbeat Monitors)
- **内置 isoSPI™ 接口**
- **BMS 芯片同步测量**
- **4.5V ~ 14V 供电电压**
- **温度范围：-40°C to 125°C**

测量 / 监控 电池堆栈电压、电流、功率、充电与温度



- **实时处理**
  - 1% 精度的功率、电能和电荷测量
  - 电荷和能量的无损跟踪
  - 内置 Tolerance & Tempco 校正因子

主动均衡与被动均衡

- 为什么要均衡?
  - 弱电池电芯将会比强或高容量电芯充电和放电更快
  - 需要使所有的电池电芯以相同的程度充电
  - 避免因温度梯度引起的老化差异

- 被动均衡 Passive Balancing
  - 具有最高SoC*的电池通过泄流电阻放电
- 主动均衡 Active Balancing
  - 在电芯之间重新分配电荷
  - 适用于不频繁充电的系统

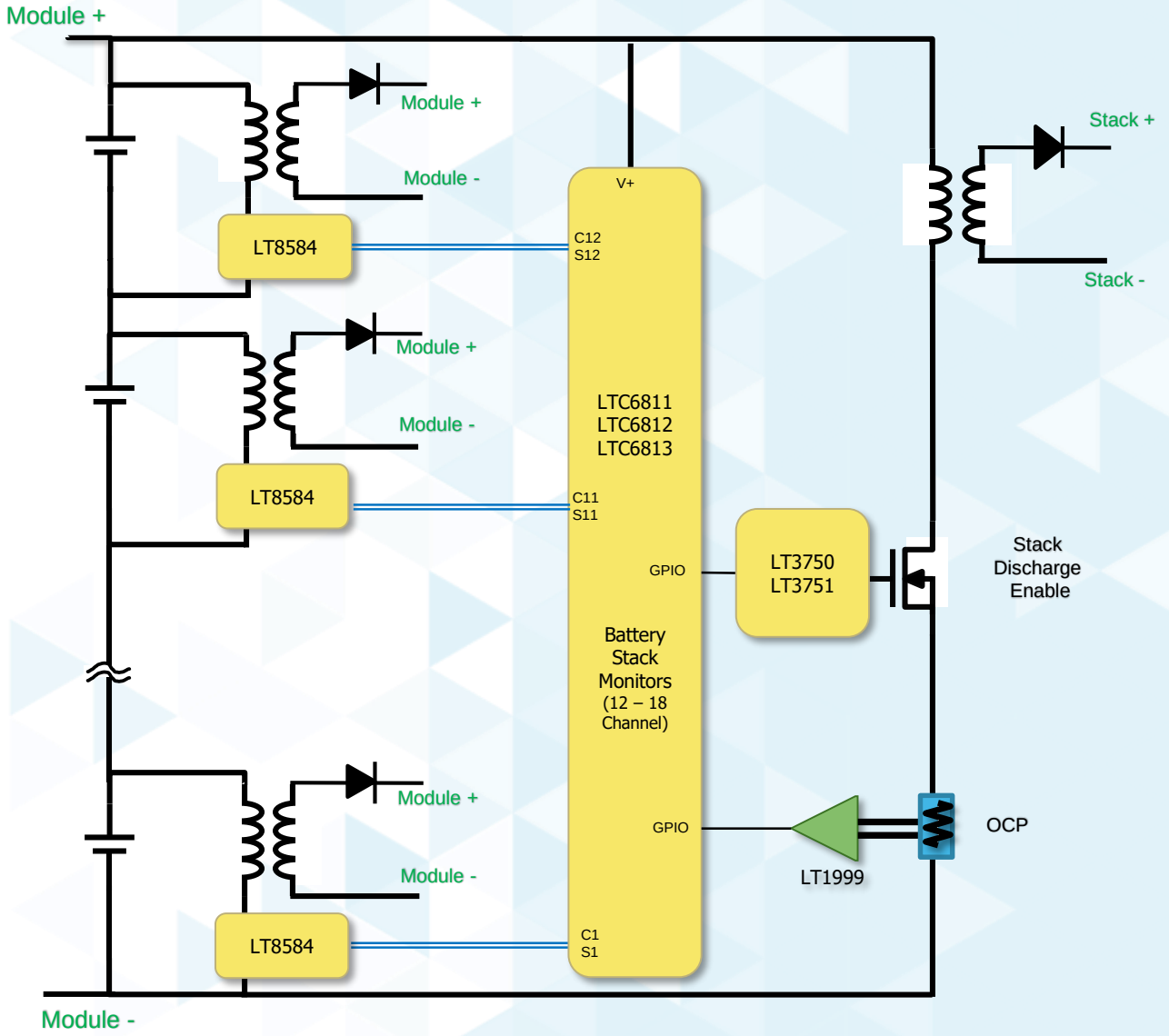
	主动均衡	被动均衡
优点	更长的系统运行时间 更短的充电时间 更好的效率	费用低 可纠正长期失配
缺点	更多的器件和费用增加	效率低 系统运行时间没有改进

*SOC = state of charge

主动均衡：LT8584 – 快速均衡

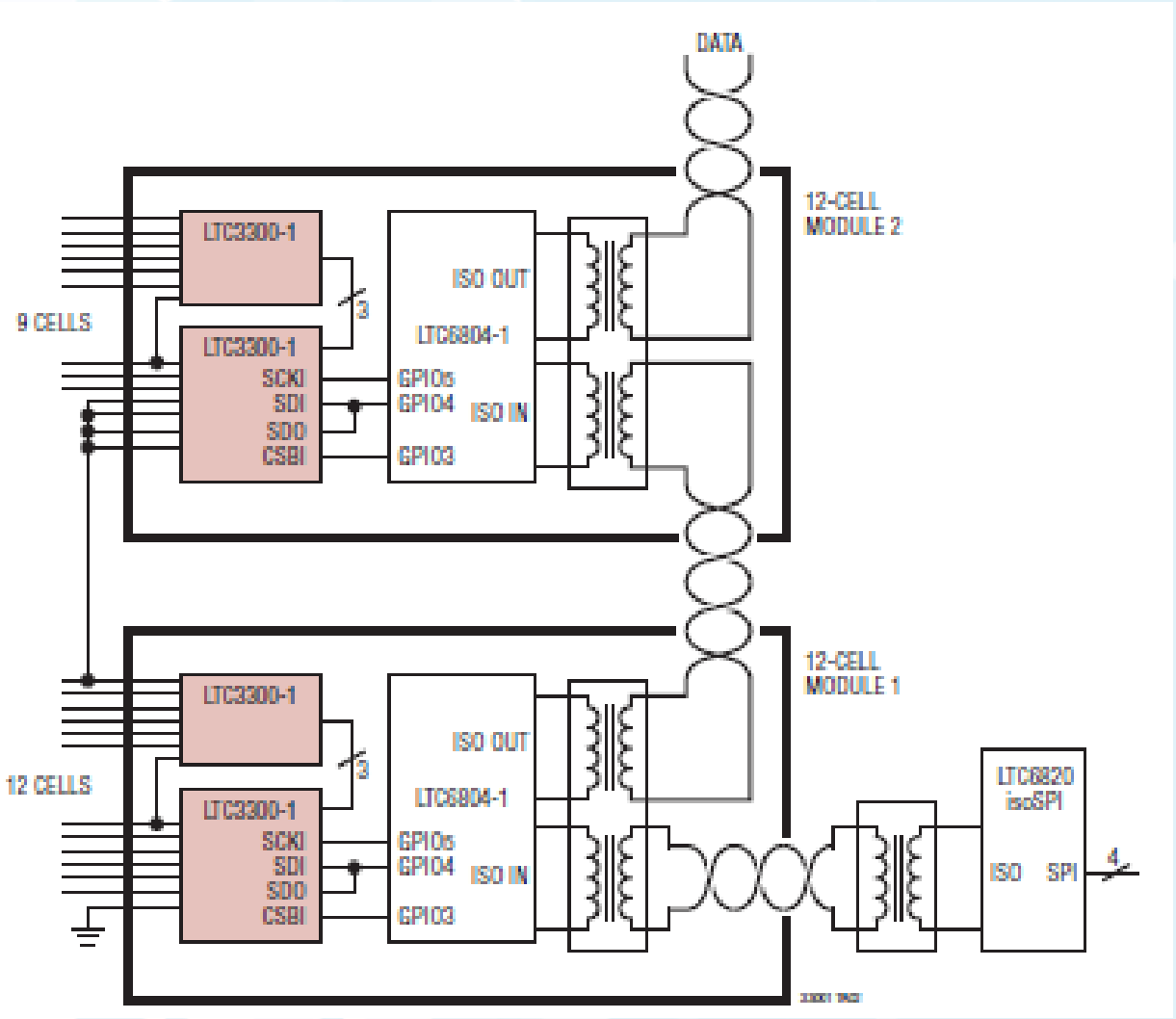
- **LT8584**
  - The LT8584 operates as a boundary mode flyback converter
  - Provides 2.5A average discharge current.
  - Scalable by using multiple LT8584s to balance each cell.
  - Each battery in the stack requires an LT8584 active cell balancer
  - 10A discharge to the stack with LT3570/71 with Mosfet
  - Integrated 6A switch

- **Safety Features**
  - **Read Back via ADC of LTC681x:**
    - Cell Voltage
    - Cell Discharge Current
    - Die Temp
    - LT8584 Handshaking Voltage (i.e. Reference V)



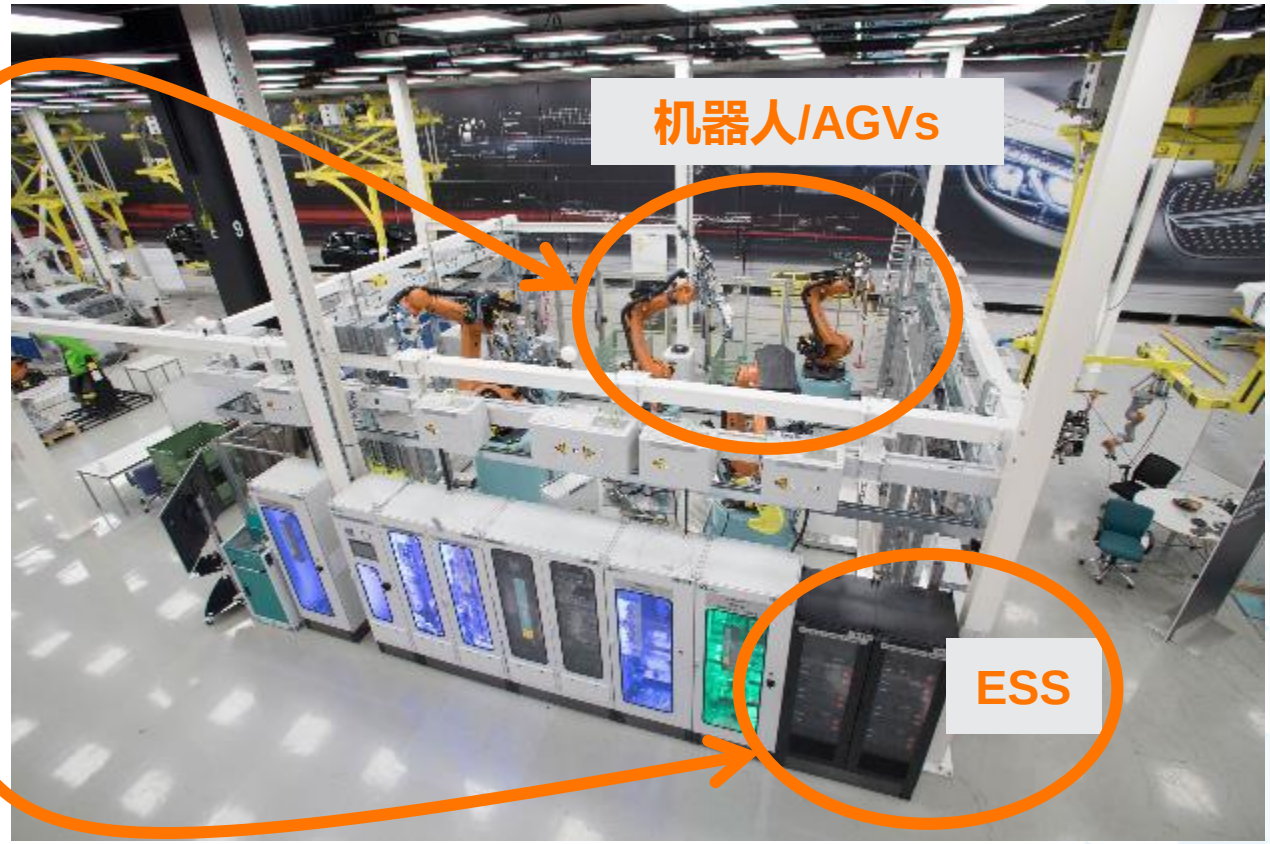
主动均衡: LTC3300

- **LTC3300**
  - Bidirectional synchronous flyback
  - balancing of 1 to 6 Li-Ion or LiFePO4 cells in series
    - *Bidirectional* architecture
    - Balancing on battery ***charge and discharge*** cycles
    - Cells can be balanced ***concurrently*** or independently
  - ***Stackable*** architecture enables >1000V systems
  - Up to ***10A balancing current*** per cell
  - 1MHz daisy-chainable serial interface with 4-bit CRC packet error checking
  - High noise margin serial communication
  - Numerous fault protection features

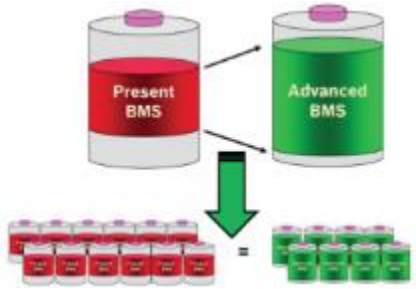


功能安全– 从汽车应用到储能系统 (ESS)

功能安全设计从汽车、铁路、航空到工业市场



BMS主板 → 关注电源和隔离通信

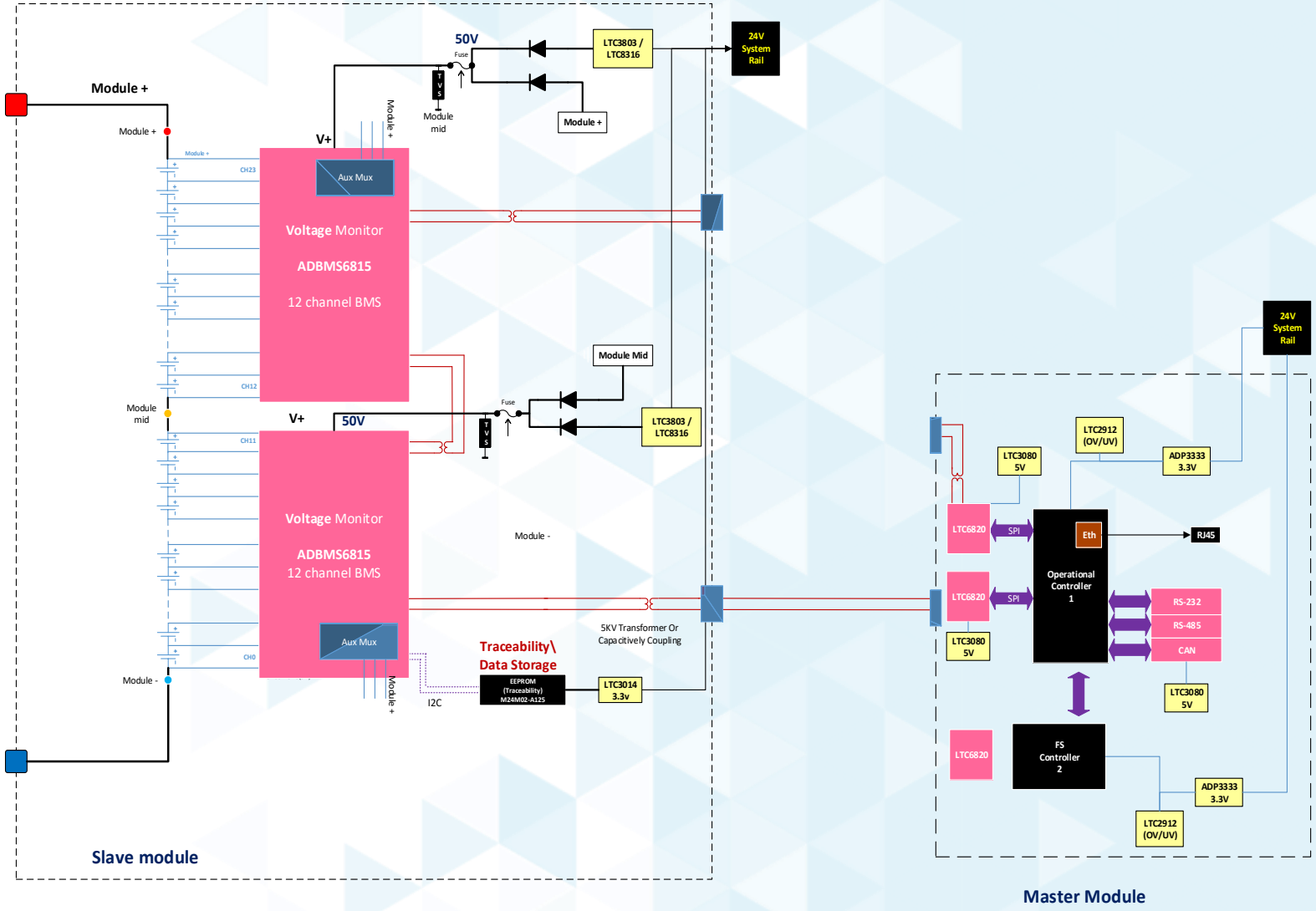


- ADI IDH: FoxBMS

  https://foxbms.org/

BMS系统的功能安全设计

- **监控**
  - ADBMS6815
  - 冗余的电压测量
    - 较低的测量精度
  - 独立的温度测量
- **电源**
  - 潜在的分离电源
  - 如果电芯出现问题，连续的电压测量
- **外部断开接触器**
  - 安全状态断开
- **预充电路**
  - 安全状态连接
- **通信**
  - isoSPI -栈(柜)内
  - CAN - 栈对栈
  - Ethernet - 外部, 到云



Client	Page 1 of 1	Prepared by	Date
FS Design BMS - ESC Group		Martin Murnane	1/10/2019
Process		Approved by	Date
name		name	6/11/2019

ADI无线网络解决方案

- 长电池寿命
  - 时间同步节能协议
- 健壮的操作性能
  - 保证数据交付
  - 可控的延迟
  - 可伸缩的网络规模
- 解决低功耗网络挑战
  - 建立在可靠的ADI低功耗硬件解决方案上
- 可靠性Reliability
  - 高质量工厂测试
  - 综合评价
- 长寿命
  - 支持长生命周期的产品

RapidNet IP

Electronic Shelf Labelling

Infrastructure health

LoWPAN

AgileNet 6T

Building Security

6TiSCH

WirelessHART

Process monitoring

SmartMesh IP™ Wireless Sensor Network

ADI SmartMesh IP Products

Chip Package

LTC5800IWR-IPMA*
QFN 10mm by 10mm

Pre-RF-Certified PCB with On-Board Antenna

LTP5901IPC-IPMA
24mm by 42mm

Pre-RF-Certified PCB with MMCX Antenna Connector

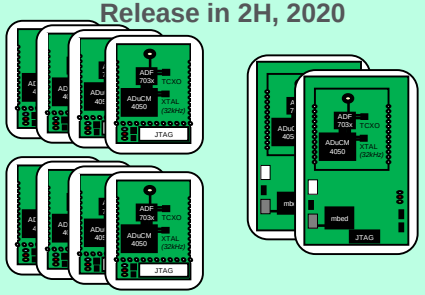
LTP5902IPC-IPMA
24mm by 37.5mm

Starter Kit DC9021B

Machine health

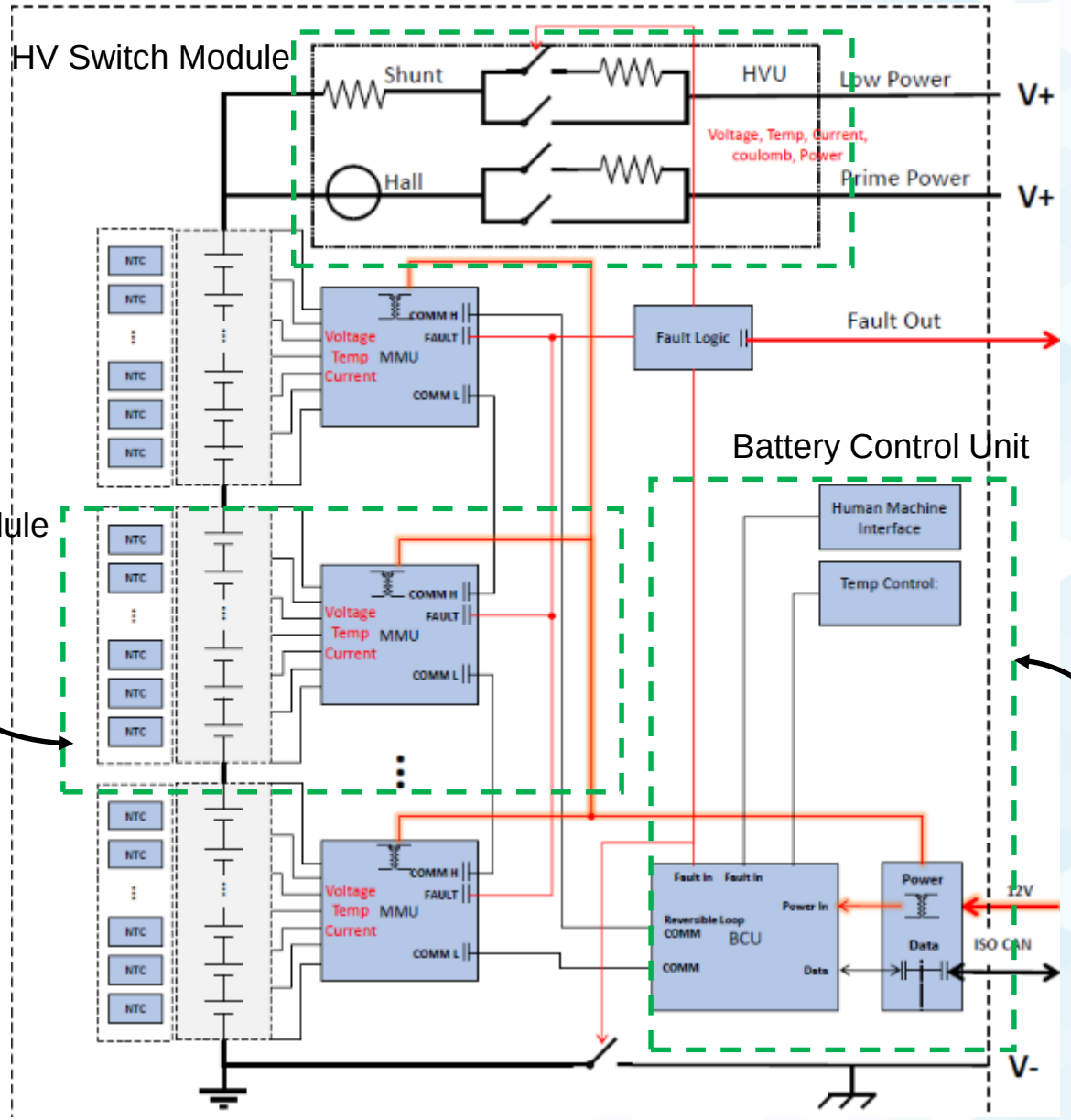
Battery Monitoring

ADI 提供针对不同协议栈，不同应用场景的短距离，微功耗无线组网产品系列定位

	ADI SmartMesh IP	WirelessHART	ADI RapidNet IP	ADI AgileNet 6T
支持芯片	LTC5800-IPMA	LTC5800-WHM	ADuCM 3029 µController ADF 7023 Xcvr	ADuCM 4050 µController ADF 7030-1 Xcvr
频率和波段	2.4 GHz World wide band	2.4 GHz World wide band	Sub GHz World wide regional bands	Sub GHz World wide regional bands
关键特点	IEEE802.15.4 兼容 Mesh 网 可扩展到1000个节点 250 kbps 数据带宽 长电池寿命	WirelessHART 兼容 Mesh 网 长电池寿命	6LoWPAN 兼容 P2MP 长距离网 可扩展到12000个节点 300kbps高下行链路BW 长电池寿命 长距离	6TiSCH 兼容 Mesh 网 可扩展到1000个节点 50 kbps 数据带宽 长电池寿命 长距离
用途	高密度网络在恶劣的工业环境中	高密度网络在恶劣的工业环境中	高密度的大型网络需要快速下载独特的消息。或需要低延迟警报消息的低密度网络	低密度的网络 分布在大面积或难以到达节点
开发环境	 Starter Kit DC9021B	 Starter Kit DC9022B		Release in 2H, 2020 

储能系统中的电池管理系统结构

储能系统结构

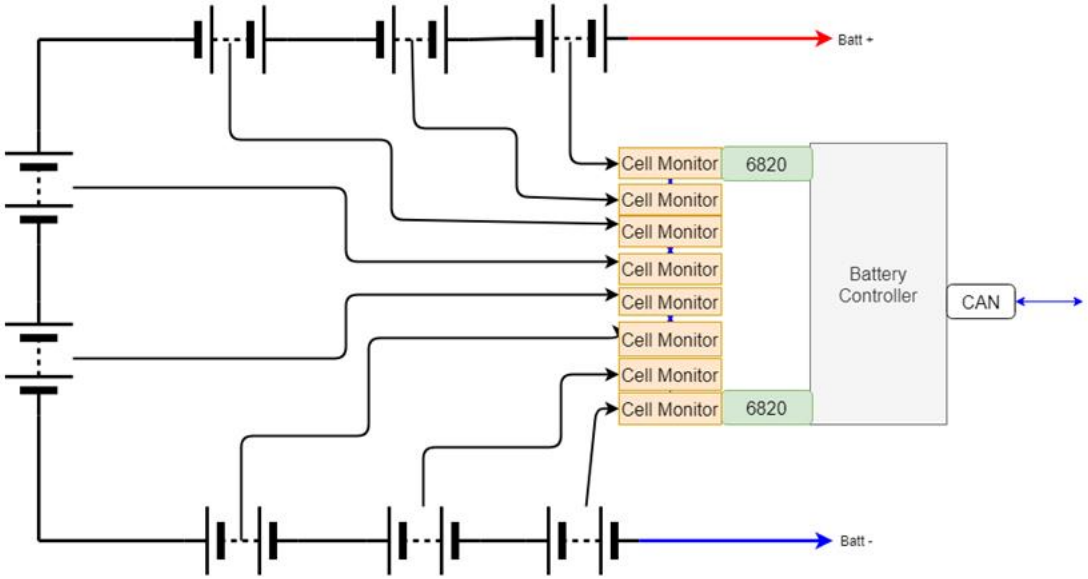


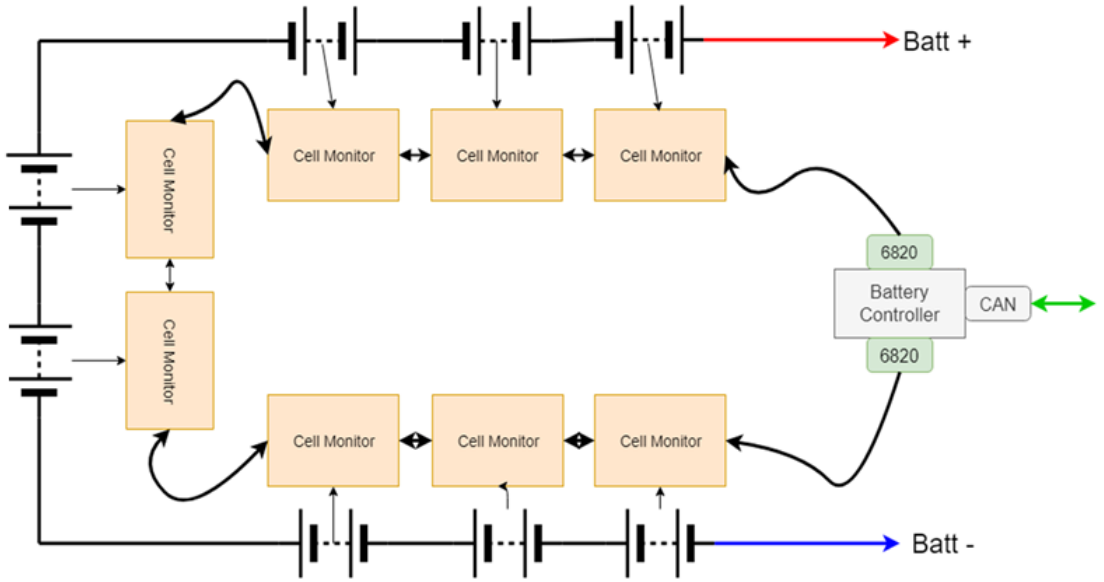
电池模块（PACK）

电池架（RACK）

电池控制单元（BMU）

不同的储能堆叠BMS模块设计



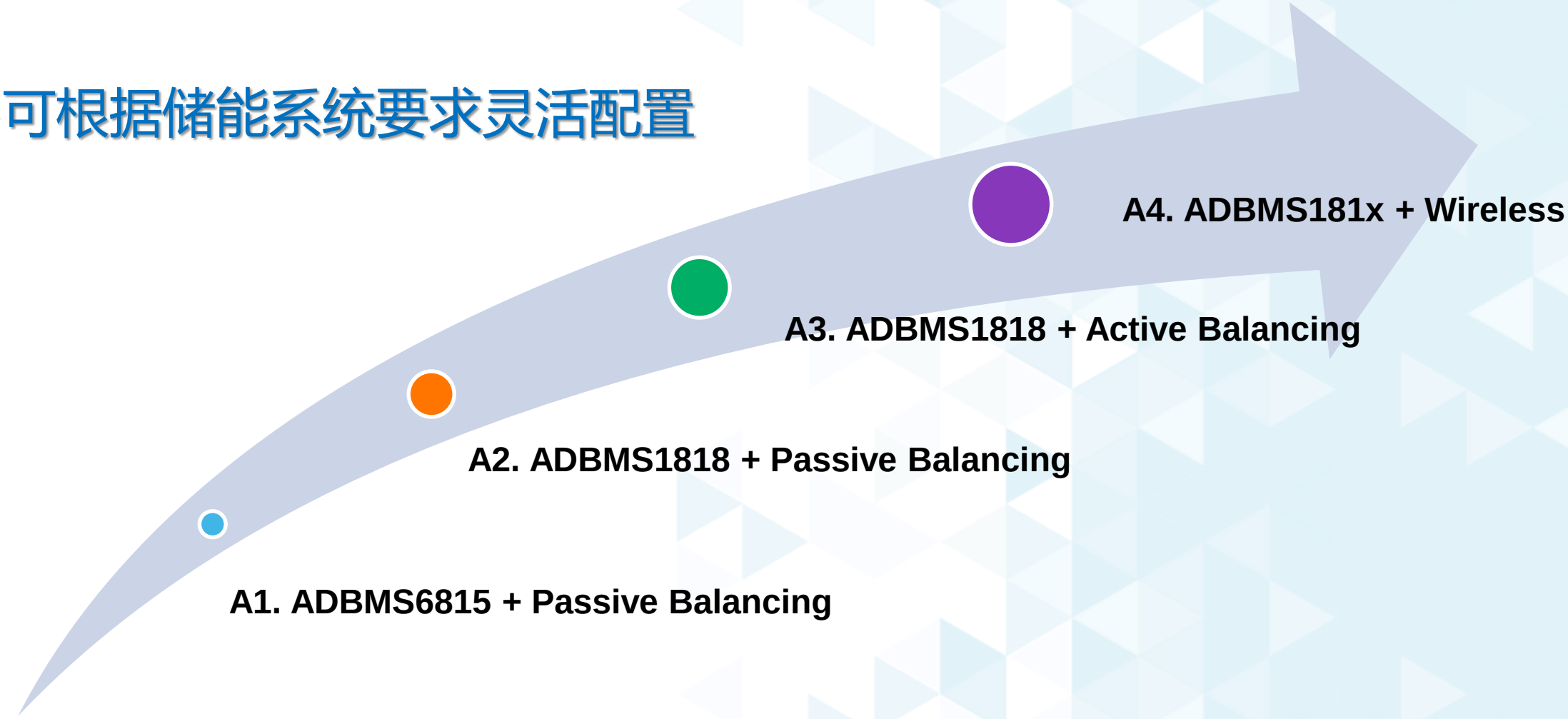


- Centralized BMS
  - Single PCB
  - Fewer communication wires
  - More complicated wiring harness
  - Works for only one pack configuration

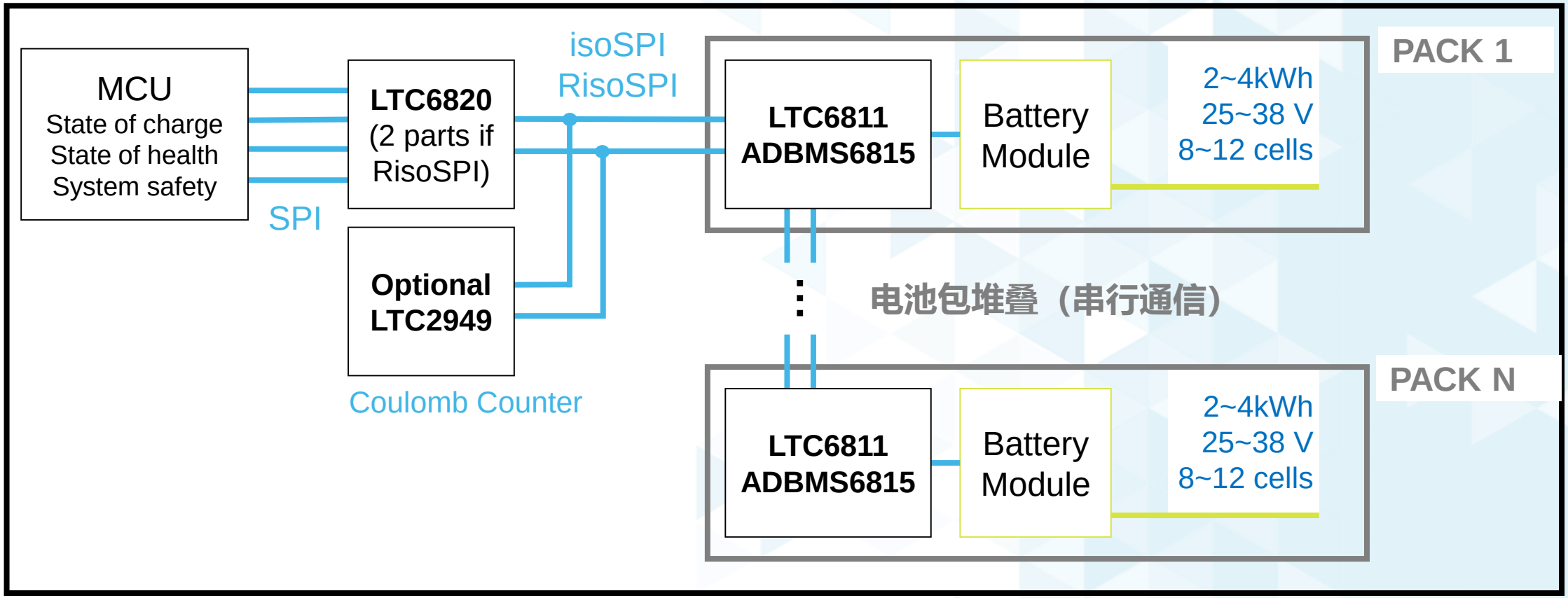
- Distributed BMS
  - Simpler CMU Board
  - Simpler Cell Harness
  - More complicated communication harness
  - Works with many pack configurations

ADI提供的BMS系统结构

- 可根据储能系统要求灵活配置



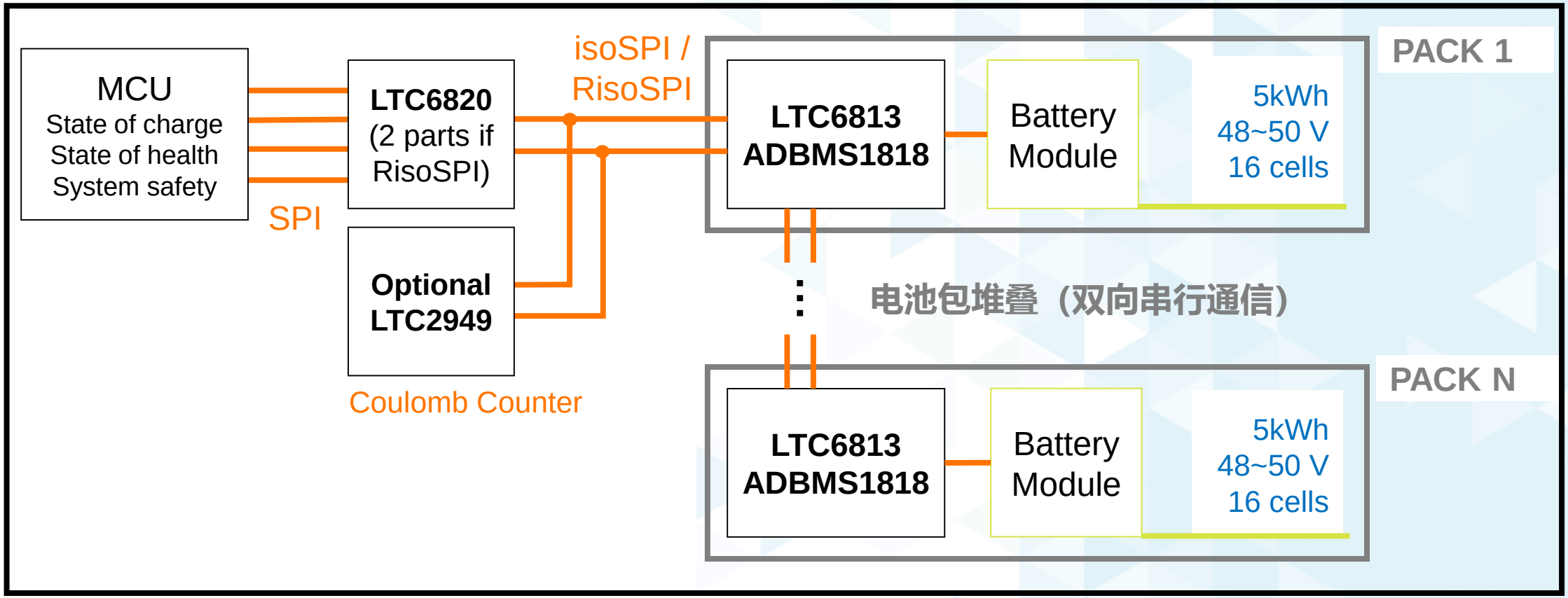
A1 ADBMS6815 + Passive Balancing 2~4KWh/Pack



系统及通信结构

优点	每kWh 低费用 工业标准
缺点	比主动均衡更低的效率 更少的模块化 电缆复杂

A2 ADBMS1818 + Passive Balancing 5kWh/Pack

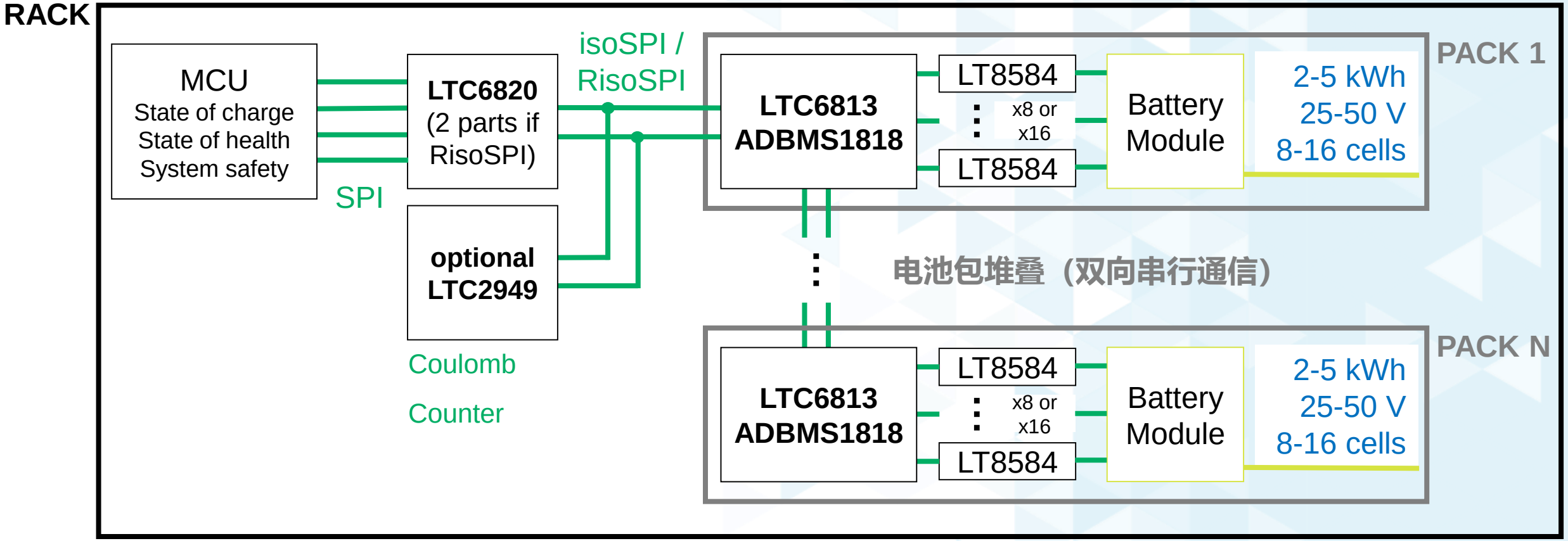


系统及通信结构

优点	可堆叠更少的电池包 每KWh 总费用更低
缺点	没有统一的标准 被动均衡比主动均衡效率低

A3

ADBMS1818 + Active Balancing 2kWh or 5kWh/Pack

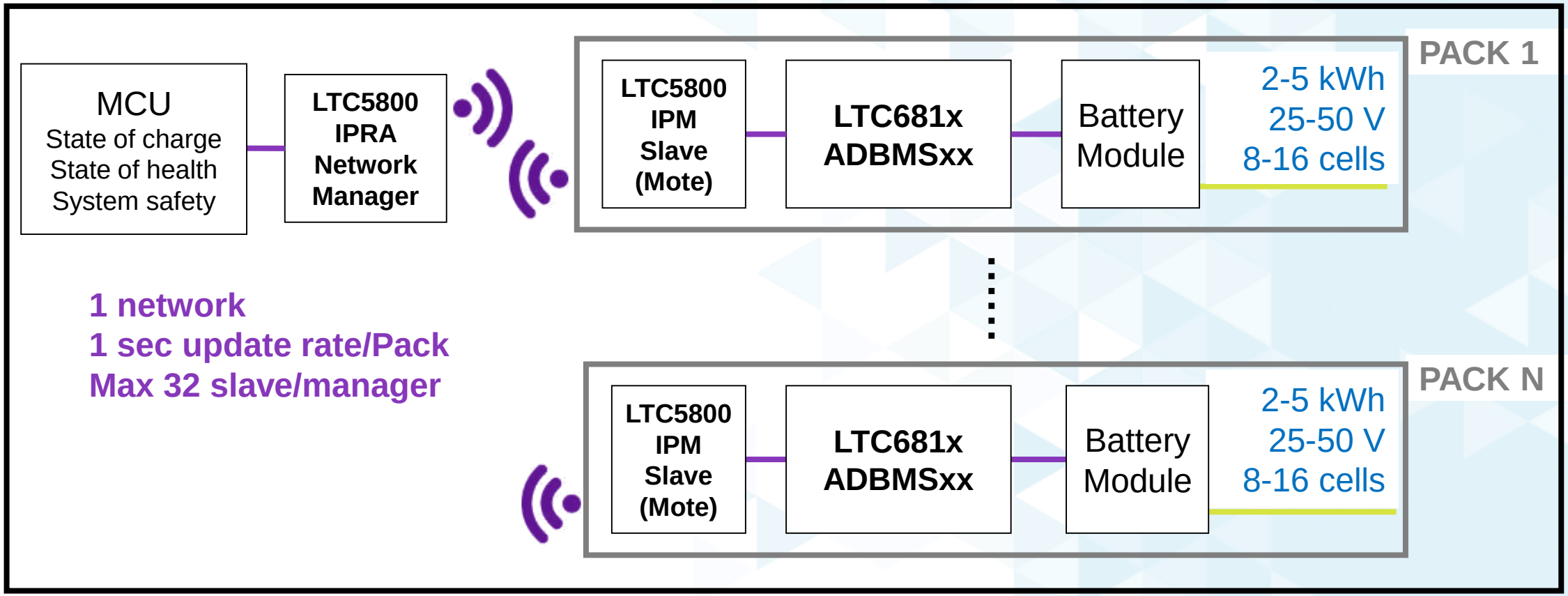


系统及通信结构

优点	更小的电池包、更长的寿命 具有较高的效率
缺点	加上主动均衡后，每KWh有更高的费用

A4

中型储能无线方案 – 可达 32 节点



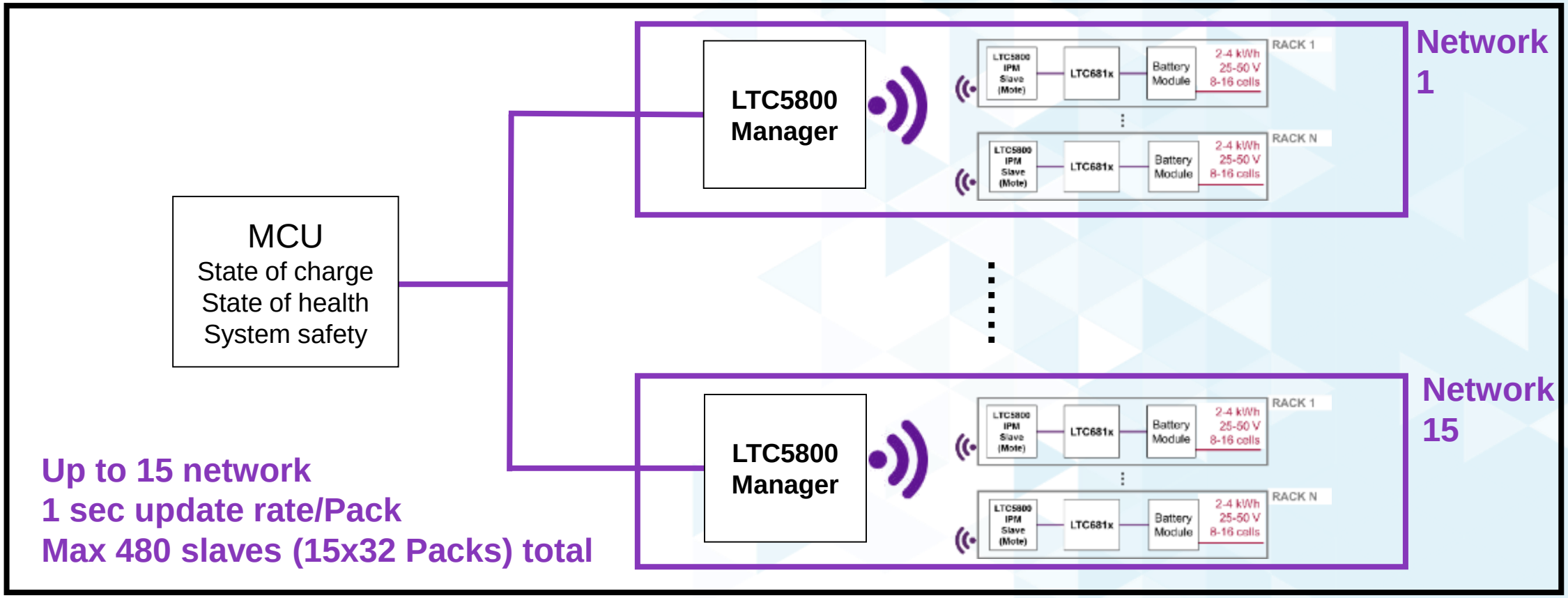
系统及通信结构

优点	更少的复杂电缆结构 低的费用 / kWh 易于安装配置 自组网技术
缺点	成本略高于有线解决方案

A4

大型储能无线方案 – 可达 480 节点

RACK



系统及通信结构

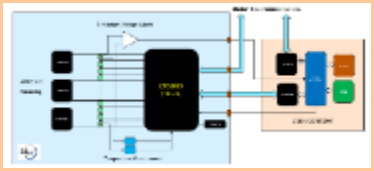
优点	更少的复杂电缆结构 低的费用 / kWh 易于安装配置 自组网技术
缺点	成本略高于有线解决方案

ADI可提供的储能结构的总结（优缺点）

	Architecture 1	Architecture 2	Architecture 3	Architecture 4
Cells/Pack	8	16	8/16	8/16
Balancing	Passive	Passive	**Active**	Passive
Wireless BMS	NO	NO	NO	**YES**
费用 / kWh (及利用)	**X $/kWh**	**-30%**	**+130%**	**+40%**
优点	工业标准	可堆叠更少的电池包 每KWh 总费用更低	更小的电池包、更长的寿命 具有较高的效率	更少的复杂电缆结构 低的费用 / kWh 易于安装配置 自组网技术
缺点	比主动均衡更低的效率 更少的模块化 电缆复杂	没有统一的标准 被动均衡比主动均衡效率低	每KWh有更高的费用	成本略高于有线解决方案

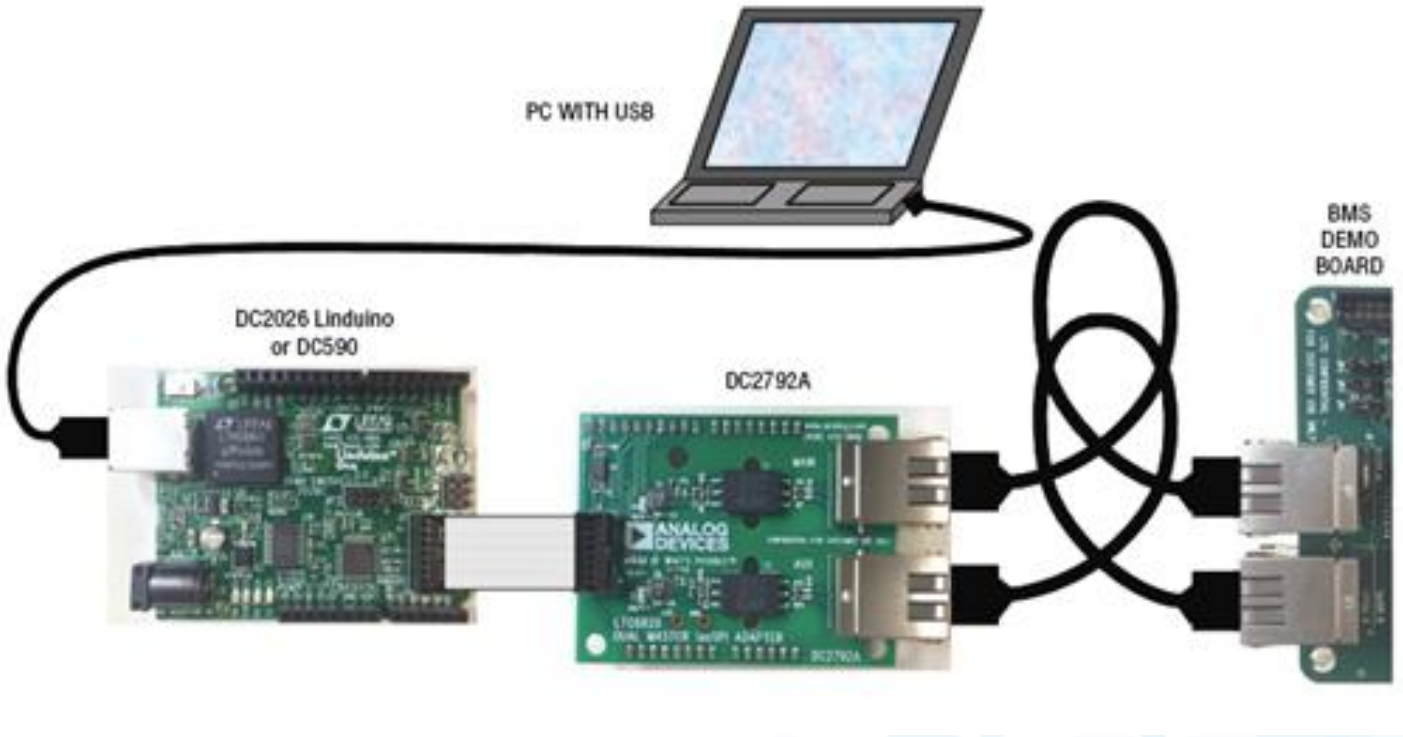
可提供的一些评估板及系统方案

https://wiki.analog.com/resources/ESC

TTR	Title / Website	Board Description	Picture	System	Schedule
1	**DC2350A-B** https://wiki.analog.com/resources/BMS	Battery Stack Monitor **LTC6813** - 18 Cells		**BMS**	**Evaluation Board**
2	**DC2350A-B** https://wiki.analog.com/resources/BMS	Battery Stack Monitor **LTC6812** - 15 Cells		**BMS**	**Evaluation Board**
3	**DC2259A** https://wiki.analog.com/resources/BMS	Battery Stack Monitor **LTC6811** - 12 Cells		**BMS**	**Evaluation Board**
4	**DC2100B-C** https://wiki.analog.com/resources/BMS	Active Cell Balancing (ACB) with LTC6804, LTC3300-1 and IsoSPI		**BMS & ACB**	**System Board**
5	**Signal Chain Demo** https://wiki.analog.com/resources/BMS	**Monitoring & Bidirectional cell balancing** with 4A charge \ discharge current using LTC6804/11 cell monitor , LTC3300, IsoSPI LTC6820, LTM288x(Iso USB), LDO's		**BMS & ACB**	**Signal Chain Demonstration** • **BSM** • **ACB**
6	**BMS System Module (in development)**	Functional Safety System level LTC6813, LTC3300, LTC6820 (IsoSPI), ADM3054(IsoCan), Safety Concept, FMEA		**BMS System Module (includes Signal Chain)**	**Finished hardware design** **Functional Safety Documents available** • **Safety Concept** • **Safety Plan** • **FMEDA**

ADBMS1818 Demo board

- EVAL-ADBMS1818 + DC2026 (Linduino) + DC2792A (LTC6820) + DC2472A (load interface board)



ADI网站可以找到更多的设计资源

- 希望得到更多的有关电池管理（BMS）和储能（ESS）的资料，可以浏览ADI网站：
  - https://www.analog.com/cn/applications/markets/energy-pavilion-home/energy-storage-power-conversion/energy-storage-systems.html
  - https://www.analog.com/cn/applications/markets/automotive-pavilion-home/vehicle-electrification/battery-management-systems-bms.html
- 网上的一些文章
  - https://www.analog.com/cn/signals/articles/renewable-energy-storage-systems.html
  - https://www.analog.com/cn/technical-articles/battery-stack-monitor-maximizes-performance-of-li-ion-batteries.html
  - https://www.analog.com/cn/technical-articles/maximizing-cell-monitoring-accuracy-and-data-integrity-in-energy-storage-battery-management-systems.html
  - https://www.analog.com/cn/signals/articles/longevity-battery-management-system.html
  - https://www.analog.com/cn/about-adi/news-room/press-releases/2020/adi-introduces-automotive-industry-first-wireless-battery-management-system-electric-vehicles.html
- 也可以从ADI的IDH网站找到设计资源
  - Nuvation Energy -- https://www.nuvation.com/electronic-design-services/solutions/energy-storage-solutions
  - FoxBMS – https://foxbms.org

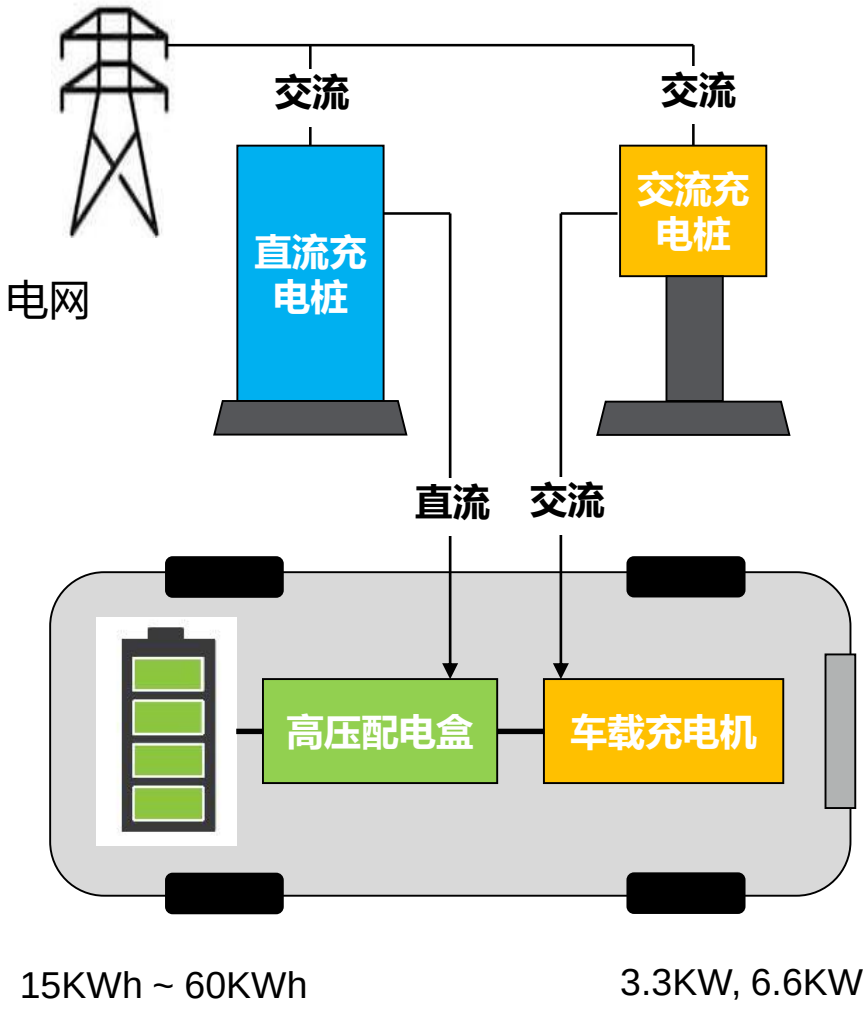
储能用于充电站建设及功率转换

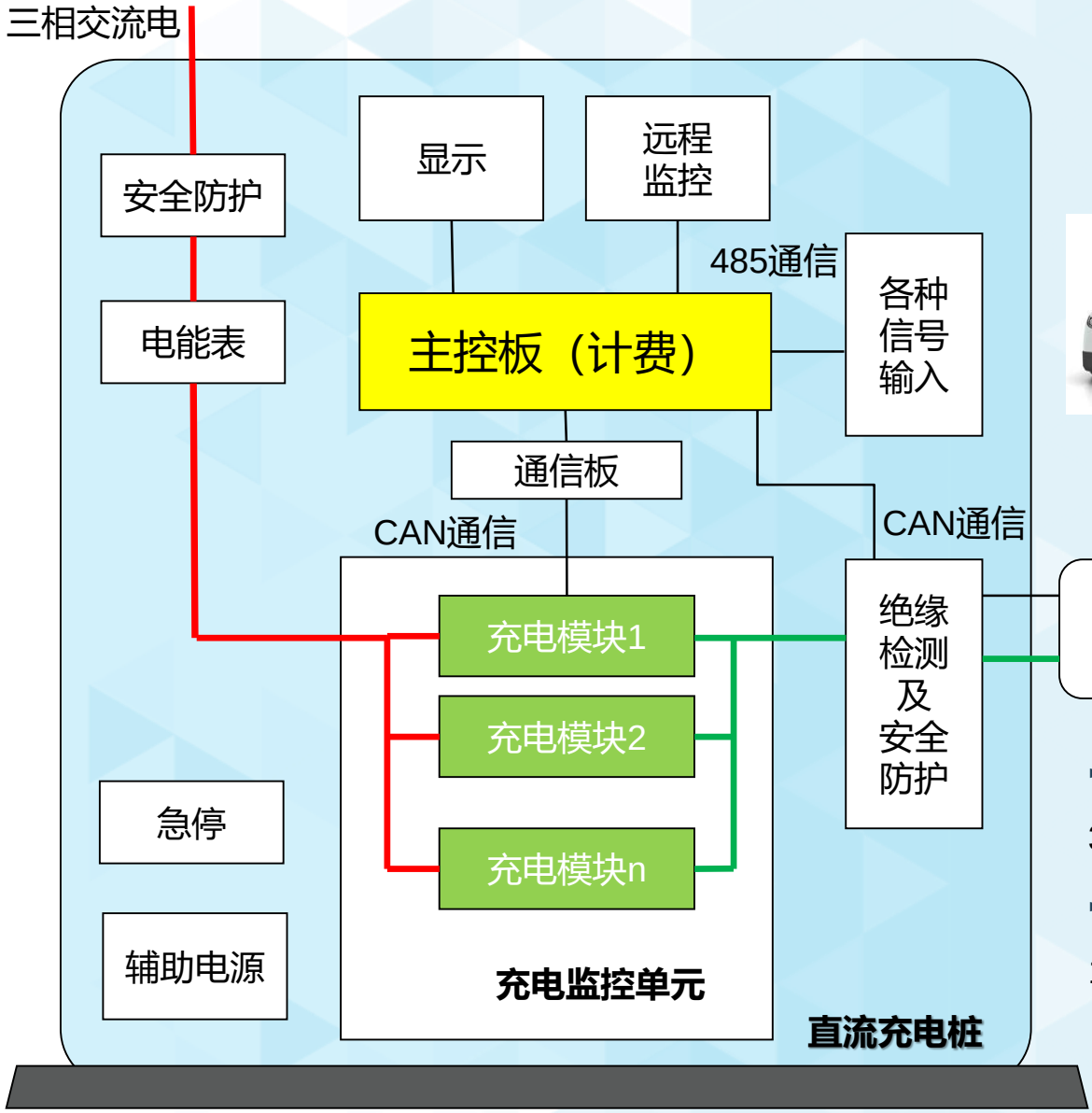
储能系统服务于充电基础设施建设

- **电池储能市场**
  - 爆发式增长: CAGR > 25%
  - 碎片化应用: 各类应用, 各种尺寸要求
  - 强调功能安全
- **对于新设计，更多要求:**
  - 安全、
  - 性能、
  - 成本效益
- **对于客户的挑战:**
  - 有限的 R&D 资源
  - 更快速推向市场

- **Bloomberg NEF “2019 Long-Term Energy Storage Outlook “**
  - 通过结合屋顶太阳能、工业园区或商业建筑的储能和充电站，共用储能和电动汽车充电正在兴起。在短期内，这类装置主要作为试点项目，为综合能源管理找到解决方案。我们**预计2023年左右电动汽车电池充电将加速。**2019年，中国启动大功率直流充电标准，以满足城市和公路沿线公共充电站日益增长的日间快速充电需求。
  - 该标准有望在2021年以后推出，届时将引入**大于250KW的充电桩**，从而实现超高速直流充电基础设施
  - 从技术上讲，在这些充电地点共用储能将是必要的，以提供足够的现场电力，而**无需额外的配电网络和变压器投资。**除了这些可避免的投资之外，通过降低需求费用和按照使用时间费率管理使用情况，**储能还可以降低充电基础设施的运营成本**

充电桩基本结构





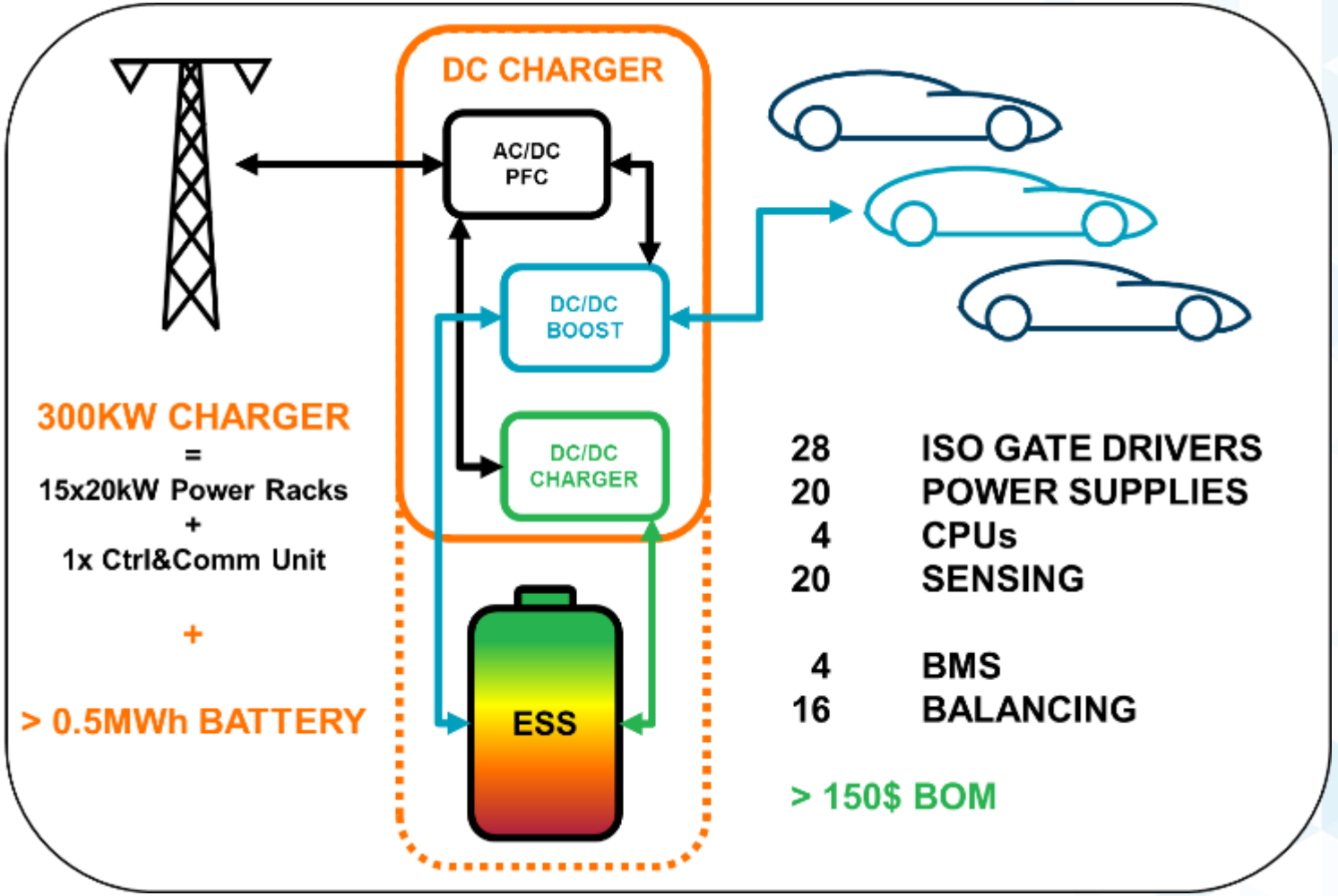
- **单枪**

30KW/60KW

- **双枪**

120KW（60+60）

未来市场 – 大功率直流充电桩与储能结合



要求

- >300kW 直流充电桩
- 15分钟内充到80%
- 80A 以上的直流电流
- 模块化设计
- 800V或更高的电压等级

增加储能的优点

- 调峰
- 电网平衡
- 太阳能利用

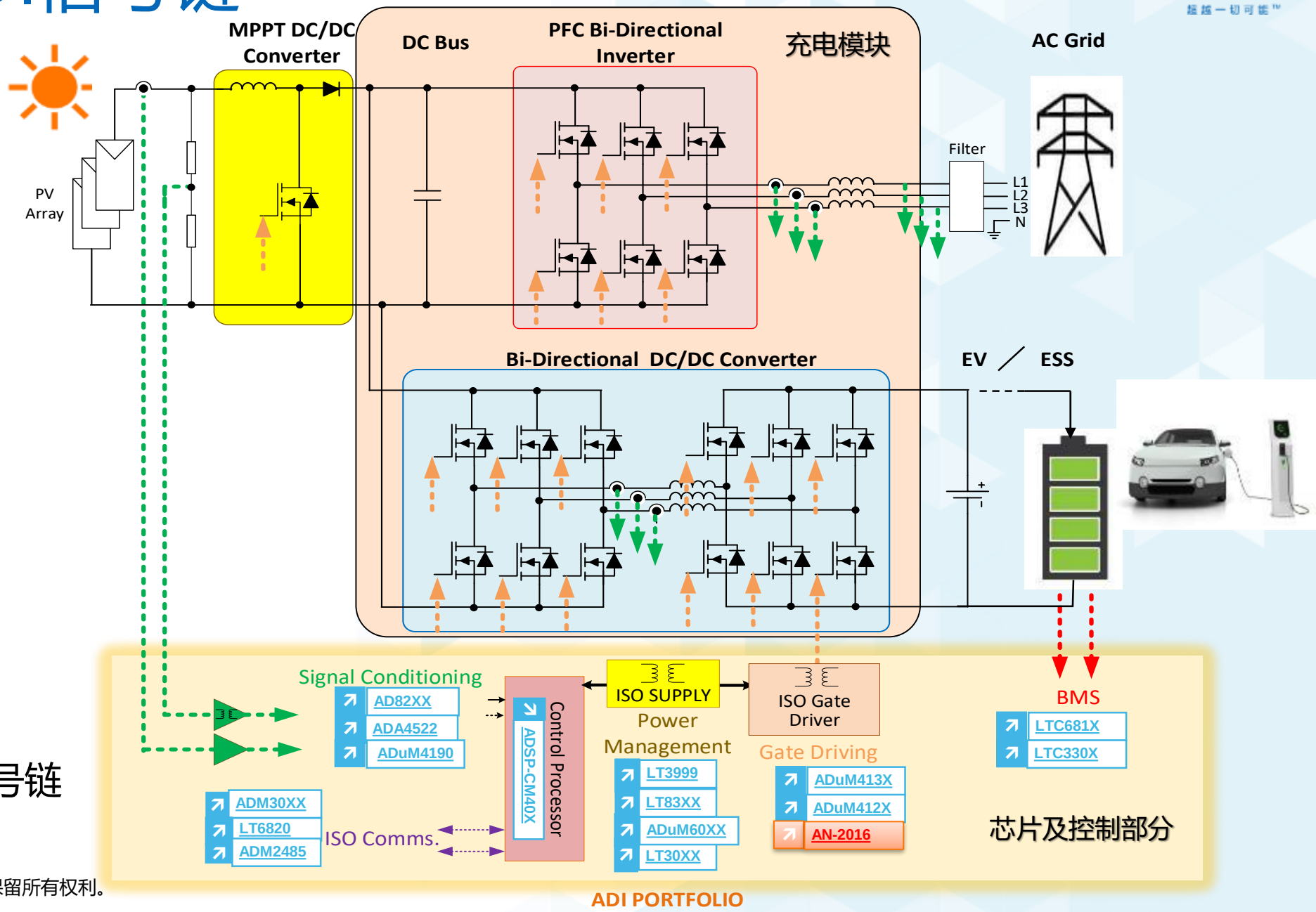
ADI 可提供

- 隔离栅极驱动
- 隔离通信及信号检测
- BMS + 均衡

直流充电桩ADI信号链

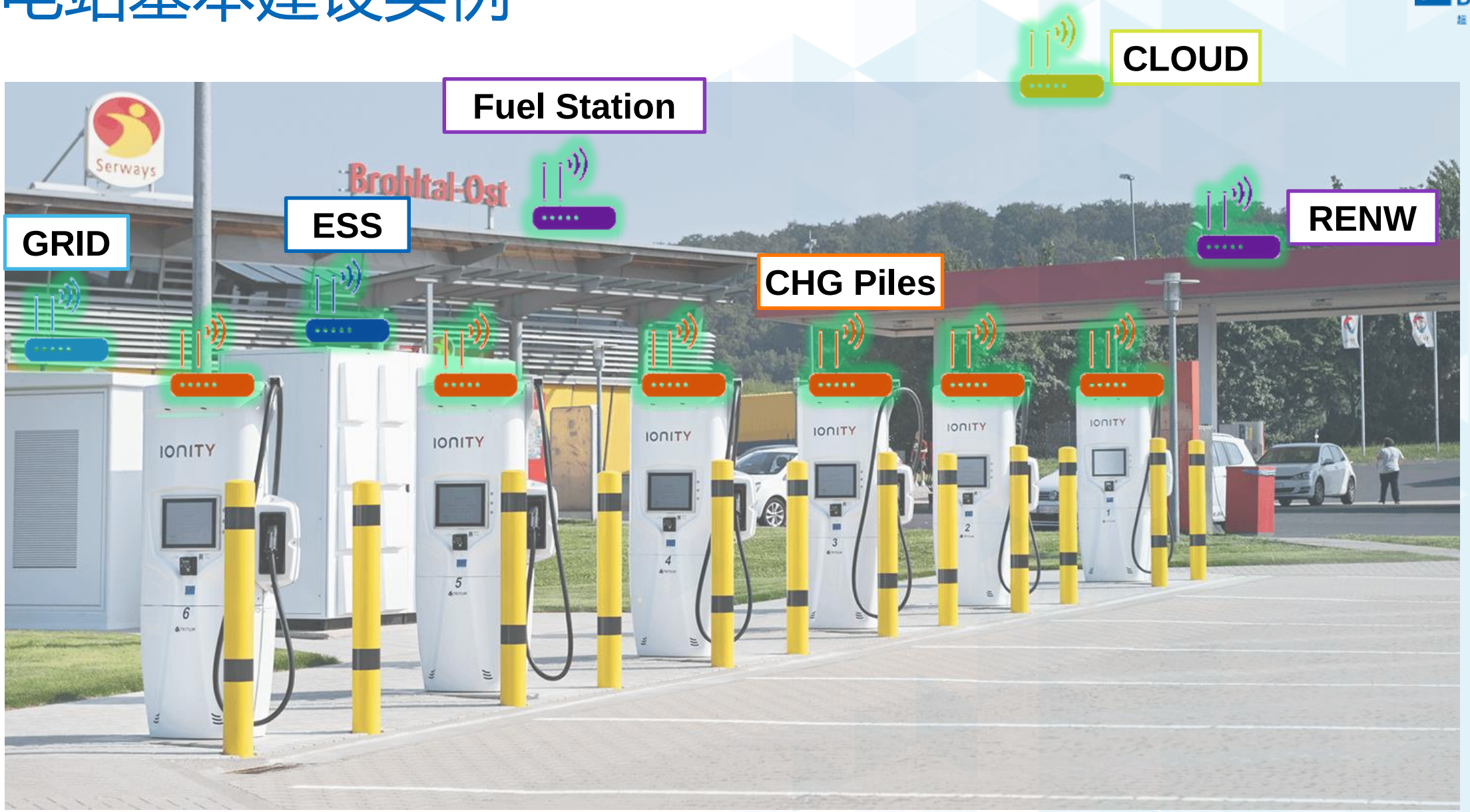
特点：

- 大功率直流桩由多个标准电源模块构成
- 电源模块尺寸基本不变
  - 15KW，20KW， 30KW
- 采用更高频率开关器件提高功率密度、减小被动器件尺寸
  - SiC， GaN
- 功率转换双向设计，可以双向功率变换
- PFC + DC/DC
- 太阳能可接入



ADI信号链

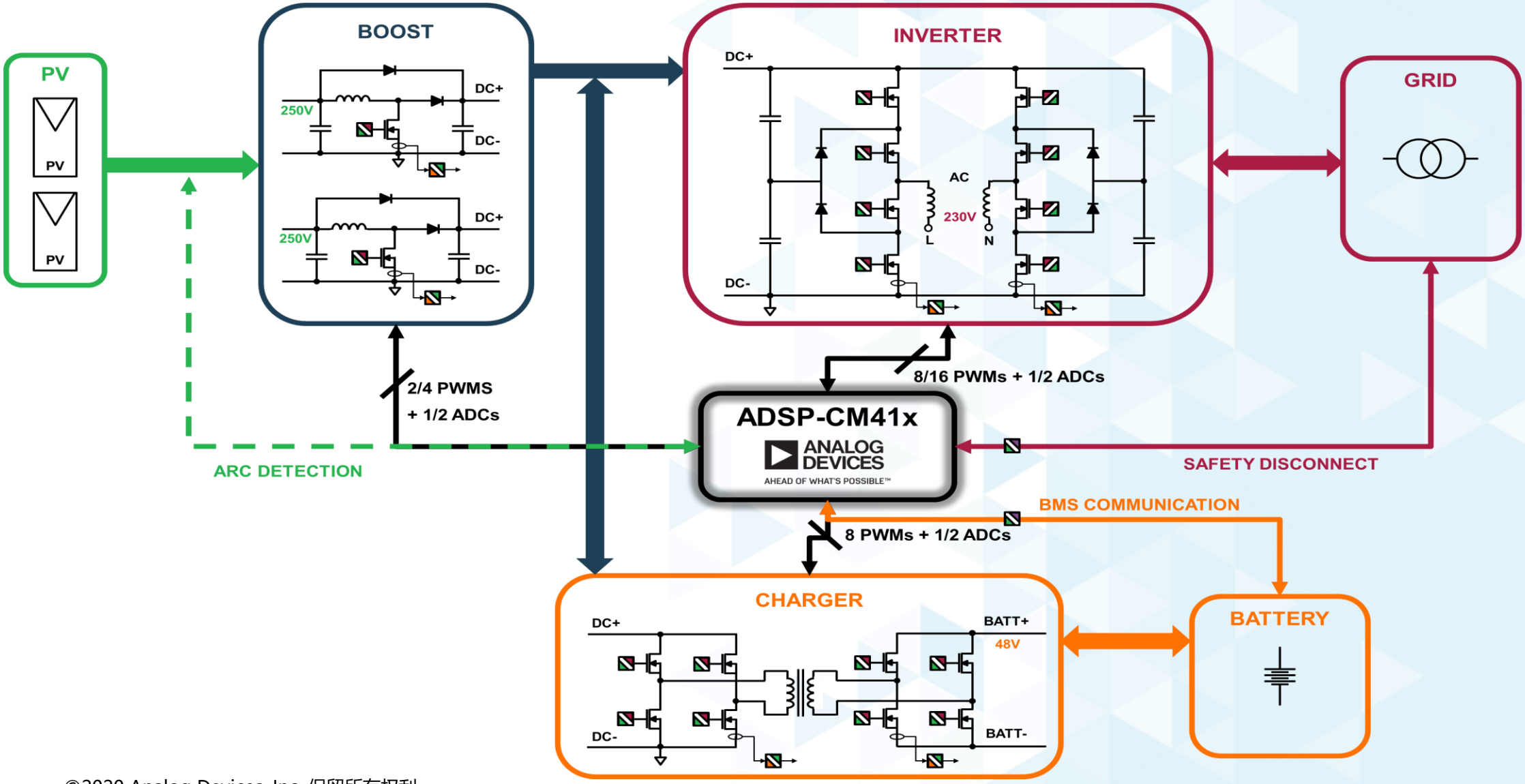
充电站基本建设实例



图片来源: https://www.electrive.com/2018/07/05/ionity-selects-ultra-fast-chargers-from-tritium/

功率转换系统设计

功率转换：光伏逆变 + 储能系统



ADI Range of Isolated Gate Driver Products

Performance

- ✓ Low Delay
- ✓ High CMTI
- ✓ Small Footprint
- ✓ Low Pin Count

Typical applications:

- On Board Charger
- DC-DC Converter

Protecting

- ✓ Low Delay
- ✓ High CMTI
- ✓ Bipolar Supplies
- ✓ Integrated Protection
- ✓ Error Reporting (flag)

Typical applications:

- Traction Inverter
- Industrial / Energy Systems

Programmable

- ✓ Low Delay
- ✓ High CMTI
- ✓ Bipolar Supplies
- ✓ Integrated Protection/Monitoring
- ✓ Status Reporting (Flag + SPI)
- ✓ Fly-back Controller
- ✓ SPI Configurable

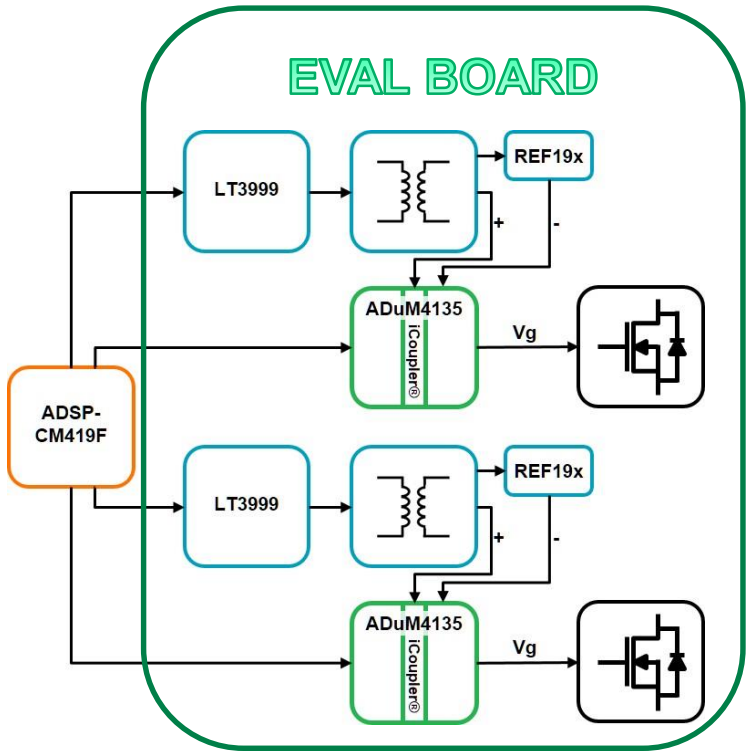
Typical applications:

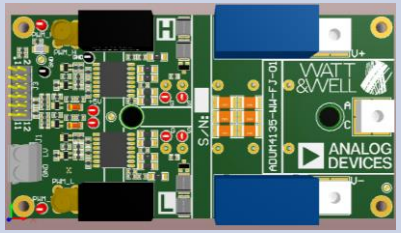
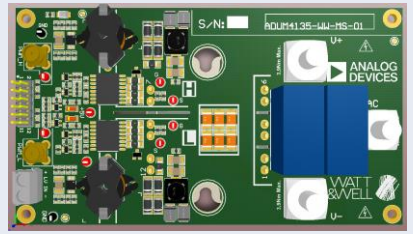
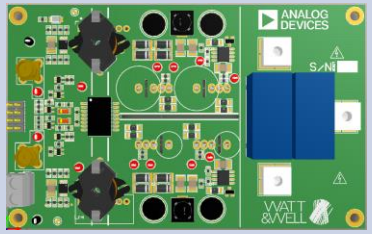
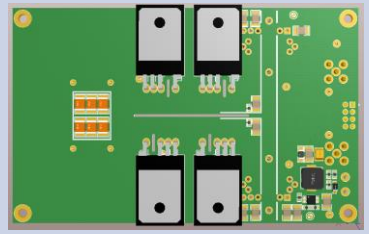
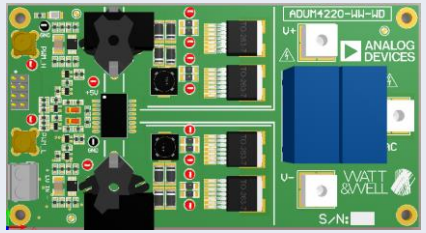
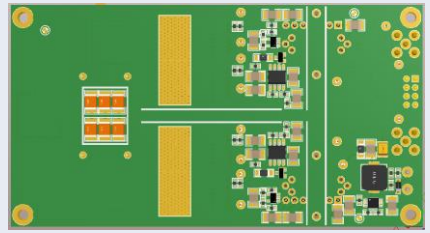
- Traction Inverter
- High Performance Industrial / Energy Systems

ADI的栅极驱动产品系列

Product	ADuM3223 / ADuM4223	ADuM7223	ADuM4135	ADuM4136	ADuM4120	ADuM4121	ADuM4137	ADuM4138	ADuM4221	ADuM4122
Features	**MOSFET/IGBT**		**MOSFET/IGBT/SiC/GaN**							
Drivers	2	2	1	1	1	1	1	1	2	1
Desat Detection			X	X				X		
Fault, Rdy, Reset			X	X			X	X		
Disable	X	X					X	X		
Bipolar Sup			X	X					X	
Miller Clamp			X			X	X	X	X	
Split Output			X				X	X		
Flyback Ctrl.								X		
Output Vdd	18V	18V	30V	30V	30V	30V	25V	25V	30V	30V
CMTI	25kV/us	25kV/us	100kV/us	100kV/us	150kV/us	150kV/us	150kV/us	150kV/us	200kV/us	150kV/us
Working Voltage	$400V_{rms}$ Basic	$400V_{rms}$ Functional	$600V_{rms}$ Reinforced $1092V_{dc}$ Basic	$600V_{rms}$ Reinforced $1092V_{dc}$ Basic	$600V_{rms}$ Reinforced $1092V_{dc}$ Basic	$600V_{rms}$ Reinforced $1092V_{dc}$ Basic	$600V_{rms}$ Reinforced $1092V_{dc}$ Basic	$600V_{rms}$ Reinforced $1092V_{dc}$ Basic	$600V_{rms}$ Reinforced $1092V_{dc}$ Basic	$600V_{rms}$ Reinforced $1092V_{dc}$ Basic
Creepage	4mm/7.6mm	3.5mm	7.8mm	7.8mm	>8mm	>8mm	>8mm	>8mm	>8mm	>8mm
Package	NSO/WSO-16	5 x 5 LGA	WSO-16	WSO-16	WSO-6 RI	WSO-8 RI	WSO-8 RI	WSO-8 RI	WSO-16	WSO-8 RI
1 Min Withstand	$3kV_{rms}/5kV_{rms}$	$1kV_{rms}$	$5kV_{rms}$	$5kV_{rms}$	$5kV_{rms}$	$5kV_{rms}$	$5kV_{rms}$	$5kV_{rms}$	$5kV_{rms}$	$5kV_{rms}$

Iso Gate Driver System Evaluation Boards for SiC



Board Specs	Picture	Schedule
SiC Power Module Half Bridge 1200V, 50A, >100kHz Fuji Electric		**Samples without Fuji module** **Test Report**
SiC Power Module Half Bridge 1200V, 40A, >100kHz Microsemi		**Samples** **Sch** **Gerber** **Test Report**
SiC Power Discrete Half Bridge 1000V, 30A, >100kHz Wolfspeed A CREE COMPANY	 	Feb18 Sch Gerber **ADuM4220**
SiC Power Discrete Half Bridge 1200V, 30A, >100kHz Wolfspeed A CREE COMPANY	 	Feb18 Sch Gerber **ADuM4220**

ADI iCoupler® is the "*Safety*" Inside

"ISOLATED GATE DRIVERS"

Sustainable Energy | **Electrification**

Highest Efficiency

Partnerships
- SiC
- GaN

***iso*Gate Drivers**

***iso*Power**

Combining to Enhance **Efficiency** & Dramatically Improve **Power Density**

Extended Working Voltage

Extending **Driving Range** in Electric Cars

Enabling Affordable **Clean Electricity**

ADI iCoupler® POWER

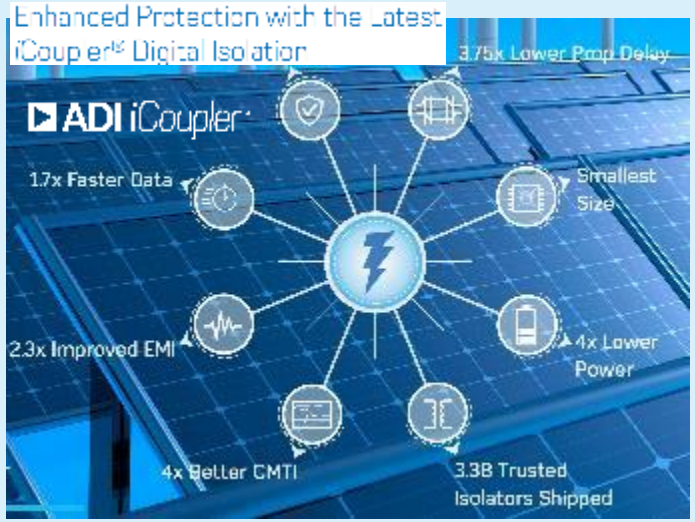
The "DIGITAL ISOLATOR"

ADI 2000: **Invented** DIGITAL ISOLATOR

ADI 2020: **3x the Size of** nearest Competitor

3.3Bn Channels Shipped: Zero Isolation Failures

Trusted Safety Global Leader in ISO



ADI iCoupler® DATA

"ISOLATED CONNECTIVITY"

Industry 4.0 | **Digital Health**

GigaBit Speed ISO

System Protocols
- I²C BUS
- USB
- CAN
- RS-485

***iso*LVDS**

Worlds Fastest **Most Robust** ISOLATION

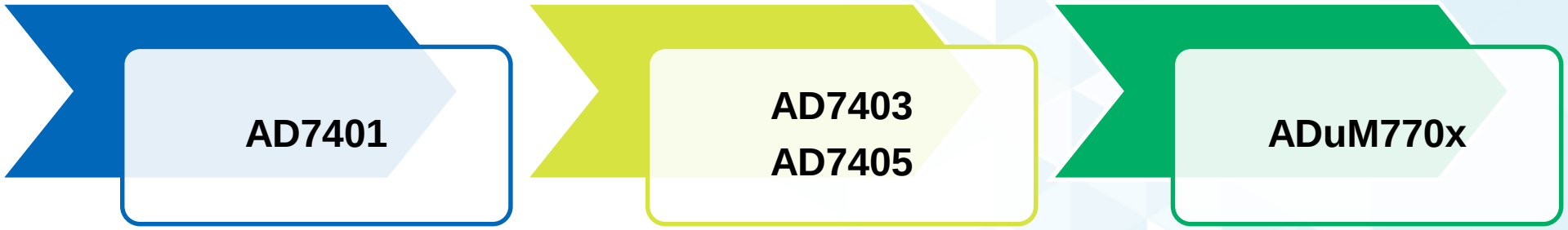
Data Integrity/Robustness

Enabling **Digital Factories**

Creating New Markets to **Enhance Healthcare Outcomes**

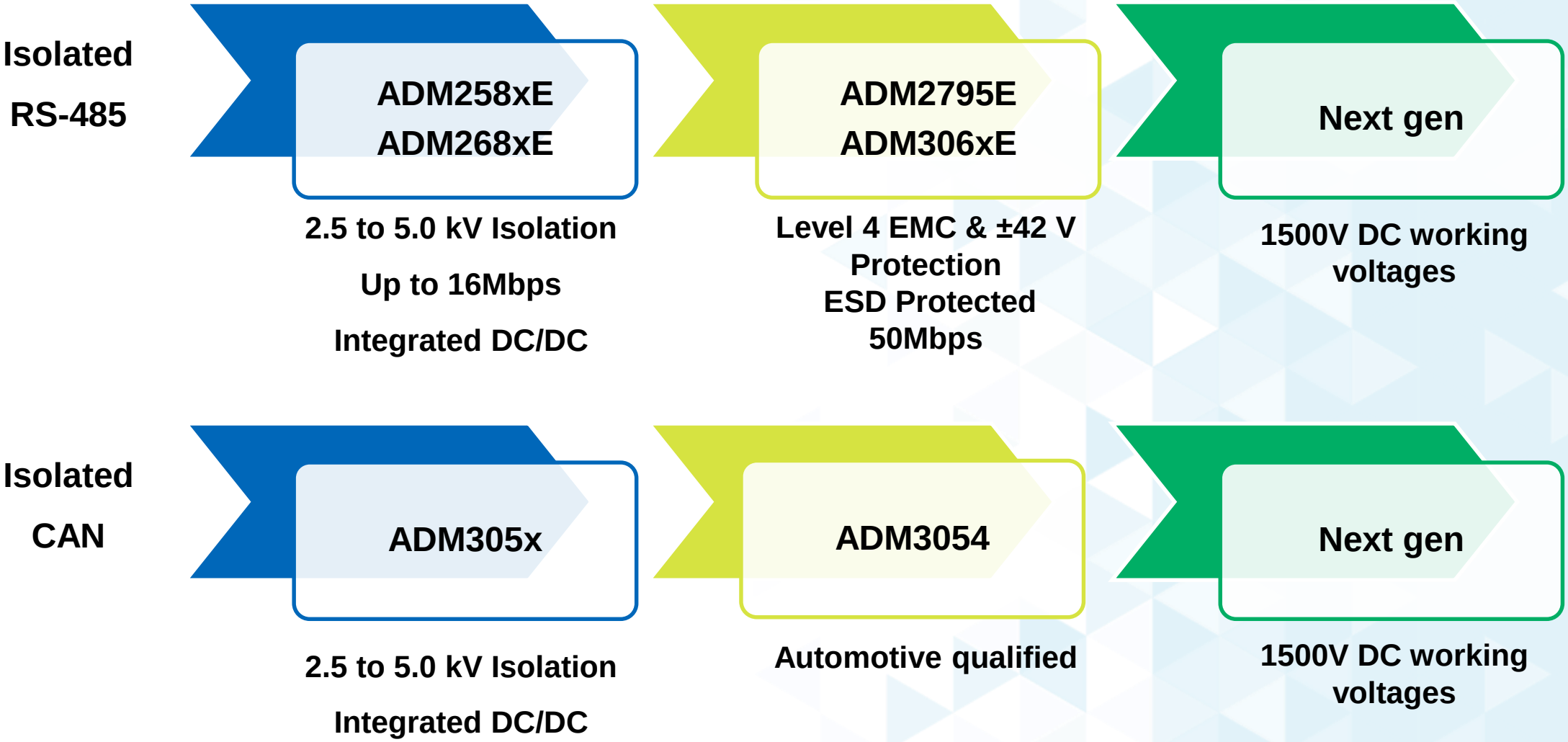
ADI iCoupler® CONNECT Gbps

Sensing ICs Overview



AD7401	AD7403 AD7405	ADuM770x
77dB @ 50mV	88dB @ 50mV	82dB @ 50mV
25kV/us	25kV/us	85dB @ 250mV
CMOS I/F	CMOS I/F	150kV/us
	LVDS I/F	CMOS I/F
		LVDS I/F

隔离 RS-485 和隔离 CAN 产品



Q & A