电动汽车电池保护

Electric Vehicle Battery Protection

——美国力特公司，杜尧生，应用技术经理
Littelfuse, Inc. YS Du, Field Application Manager

演讲嘉宾信息

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【嘉宾简介】

杜尧生先生是力特公司电子部的应用技术经理，负责电路保护标准研究、EMC解决方案、技术支持，并为华北区客户提供完整的电路保护方案。获得中国地质大学学士学位，为力特服务超过10年。

【演讲题目】

电动汽车电池保护

Electric Vehicle Battery Protection

【演讲摘要】

对个人移动性逐渐增长的需求驱动了道路上车辆数量的增加。特别是高度城市化的地区，这种愿望与我们对追求更加健康和生活质量的意愿是相矛盾的，因为空气污染和雾霾也随道路上汽车数量的增多而加重。因此，对效率更好、排放更小甚至零排放的车辆的需求迅速上升。

从有电动辅助电机的高效率内燃机（通过混合动力驱动系统）到全电动系统都属于旨在实现低排放或零排放的发动机概念。几乎所有概念都具有使用锂离子电池来为电动机提供电力的共性。尽管锂离子电池较其它电池技术（如铅酸电池或镍-金属氧化物电池）有着许多优点，但也存在一些缺点，需要对锂离子电池的状态进行适当的监测和控制。

由于为电动汽车提供电力的绝大多数电池组由若干锂离子电池组成的，关键是要确保设计出有效而且可靠的电池管理系统，以保证电池组的安全运行。监测单个电池或电池组的电压是此类电池管理系统的一个关键功能。然而，在故障情况下，可能会有大量的能量以非常快的速度释放，从而导致出现不安全的状况。对于用电线路和电池监测感应线路来说，适当的保护方案是必不可少的。

本次研讨会将会介绍锂离子电池的电气基础知识，电动汽车所用的不同类型和不同配置的电池，以及各自具体的保护需求。

electronica China

Electric Vehicle Battery Protection
电动汽车电池保护

Shanghai Electronica 2016
2016国际电动车创新发展论坛

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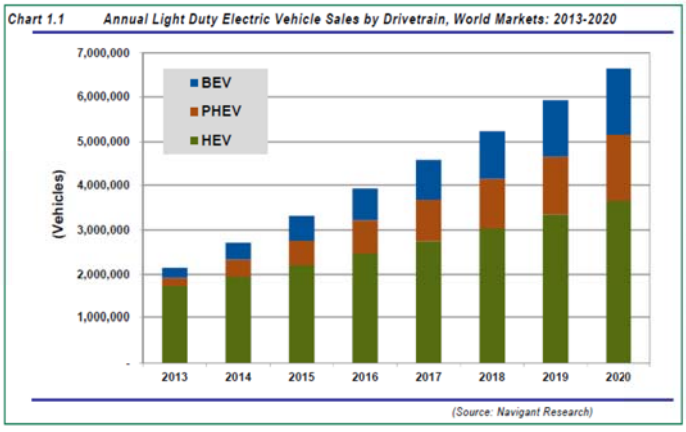

Source: Navigant Research 2013

Source: CONTINENTAL AG 2013

- Market for Vehicles with any form of higher voltage (>12 or 24V) electric system is expected to show CAGR of ~15% to ~30% until 2020
  具有任何形式较高电压(大于 12 V 或 24 V)电力系统的汽车市场预计在 2020 年之前将表现出约 15% 至约 30% 的年复合增长率
- Besides the growing number of BEV, PHEV and HEV cars, the new 48V Mild Hybrid or Eco Drive systems will significantly contribute to the growth
  除了纯电动汽车、插电式混合动力汽车和混合动力汽车的数量增长之外，新型的 48V 轻度混合动力或经济驾驶系统也将显著促进增长
- Key driver is the demand for improved air quality by lower or zero emissions, requiring better efficiency of cars
  主要驱动力是对通过低或零排放而改善空气质量的需求，对汽车提出更高的效率要求
- Additional driver is the overall increasing number of electric loads in a car, requiring higher voltages and more powerful electric systems
  另一种驱动力是汽车中电负载整体数量渐增，要求更高的电压和更强大的电力系统

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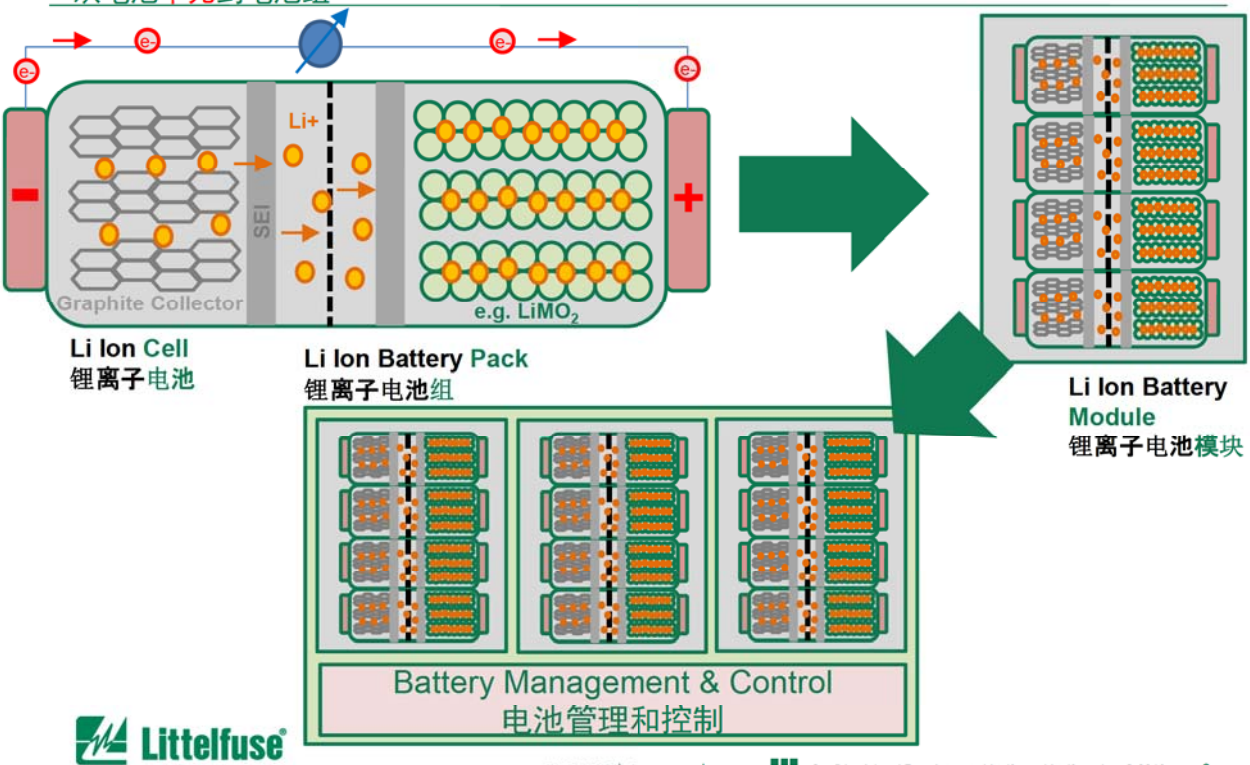
The Lithium Ion Electric Battery System
锂离子电池系统
From Cell to Pack
从电池单元到电池组



The Lithium Ion Electric Battery System
锂离子电池系统
Li Ion Batteries vs Other Battery Types
锂离子电池与其他类型电池

Attributes	Lead Acid	NiMH	Lithium Ion
Weight	Poor	Fair	Good
Energy Density	Poor	Fair	Good
Discharge Power	Fair	Fair	Good
Charge Power	Good	Fair	Good
Temperature	Good	Fair	Poor
Cycle Life	Poor	Good	Good
Calendar Life	Poor	Fair	Fair
Cost	Good	Fair	Poor
Typical Cell Voltage	2V	1.2V	3.3V to 3.7V
Safety Requirements	Low	Medium	High

- Lithium Ion Battery Technology is continuously improving and provides best cost / functionality required
  锂离子电池技术在不断改进，并提供了所需的最佳成本/功能性
- Cost for Li Ion Batteries is expected to reduce in the next couple of years by a factor of 3 to 4 and energy density is supposed to increase by the same factor
  锂离子电池成本在未来几年里预计将降低四分之一到三分之一，而能量密度具有相同的增长幅度

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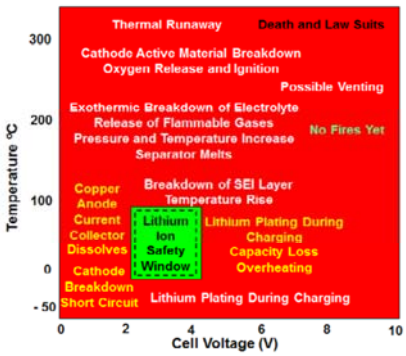
Safety with Li Ion Battery Systems
锂离子电池系统的安全性
Why Battery Management is essential
为什么电池管理必不可少

- Li Ion Batteries only operate safely and reliably within certain limits:
  锂离子电池只能在一定限制条件下安全可靠地运行：
  - **State of Charge**: Safe and reliable battery operation only possible within a certain range of the state of charge; High dis-charging and over charging reduce the efficiency and life time of Li Ion batteries; ideal SoC is between ~20% to ~90% of the max. charging
  - **荷电状态**：只有当荷电状态在一定范围内时电池才能安全可靠地运行；高放电和过充电会降低锂离子电池的效率和寿命
    理想的荷电状态为最大充电量的 20% 至 90% 左右
  - **Safe cell operating voltage**: Maintain cell voltage in between min. ~2V and max. ~4.2V. Too high cell voltage can cause excessive currents flowing, in the worst case shorts due to dendritic lithium plating can destroy the cell. Undervoltage can cause a breakdown of the electrode materials which in the worst case also results in a cell shorting.
  - **安全电池工作电压**：保持电池电压在最低 2 V 和最高 4.2 V 之间。过高的电池电压会导致过多的电流流动；在最坏的情况下因锂树突引起的短路会破坏电池。
  - **Thermal management:** Temperature control is especially important as excessive temperature can cause a chain reaction in negative processes causing dangerous situations due to potential shorting of electrodes as well as outgasing of flammable gases from organic solvents (electrolyte).
  - **热管理**：温度控制尤为重要，因为过高的温度可能会在负极过程中导致一种联锁反应，从而导致因可能的电极短路以及可燃气体从有机溶剂（电解液）中除气而发生危险情况。

Lithium Ion Cell Operating Window



Source: Woodbank Communications Ltd, www.mpoweruk.com

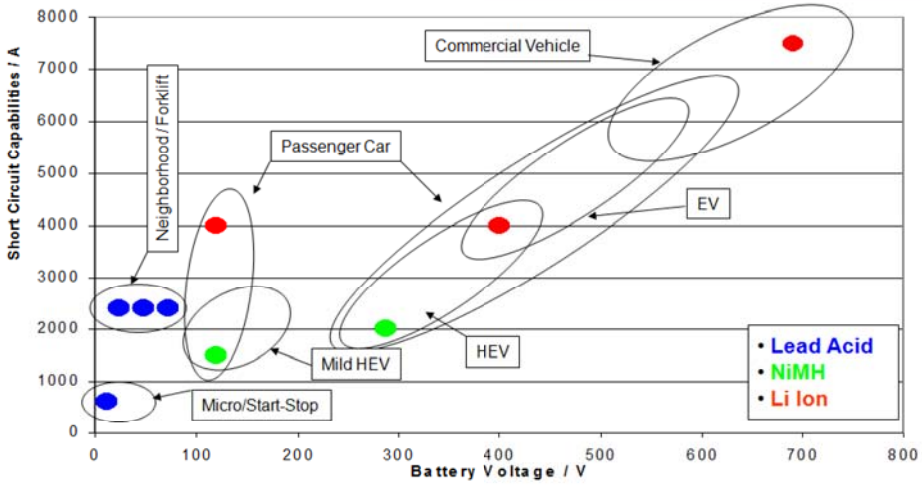
- Li Ion Batteries require careful monitoring and regulation via a **Battery Management System**

  锂离子电池需要通过电**池管理系统**进行仔细监测和调节

- Protection of the Battery Management System itself is required to keep this important system reliable and safe under all conditions (assembly, maintenance, normal operation)

  对电池管理系统本身进行保护是保证这一重要的系统在所有情况下（组装、保养、正常操作）安全可靠所必需的。

Safety with Li Ion Battery Systems
锂离子电池系统的安全性
Why Battery Management is essential
为什么电池管理必不可少



- Li Ion Battery Systems can drive significant currents on power lines under short circuit conditions; proper fusing with high interrupt capable fuses like the Littelfuse 0HEV Series is recommended
  锂离子电池系统在短路情况下会在电力线上引起强大的电流；推荐使用具有较高分断能力的保险丝的合适的熔断技术，如力特公司的 0HEV 系列
- Battery Management Systems are normally connected via high impedance sense lines, therefore short circuit currents are significantly reduced and allow usage of electronic fuses; voltage requirements depend on the battery construction
  电池管理系统通常通过高阻抗感应线连接，因此短路电流会显著降低，并允许使用电子保险丝；电压要求取决于电池结构

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EV- / PHEV Architecture
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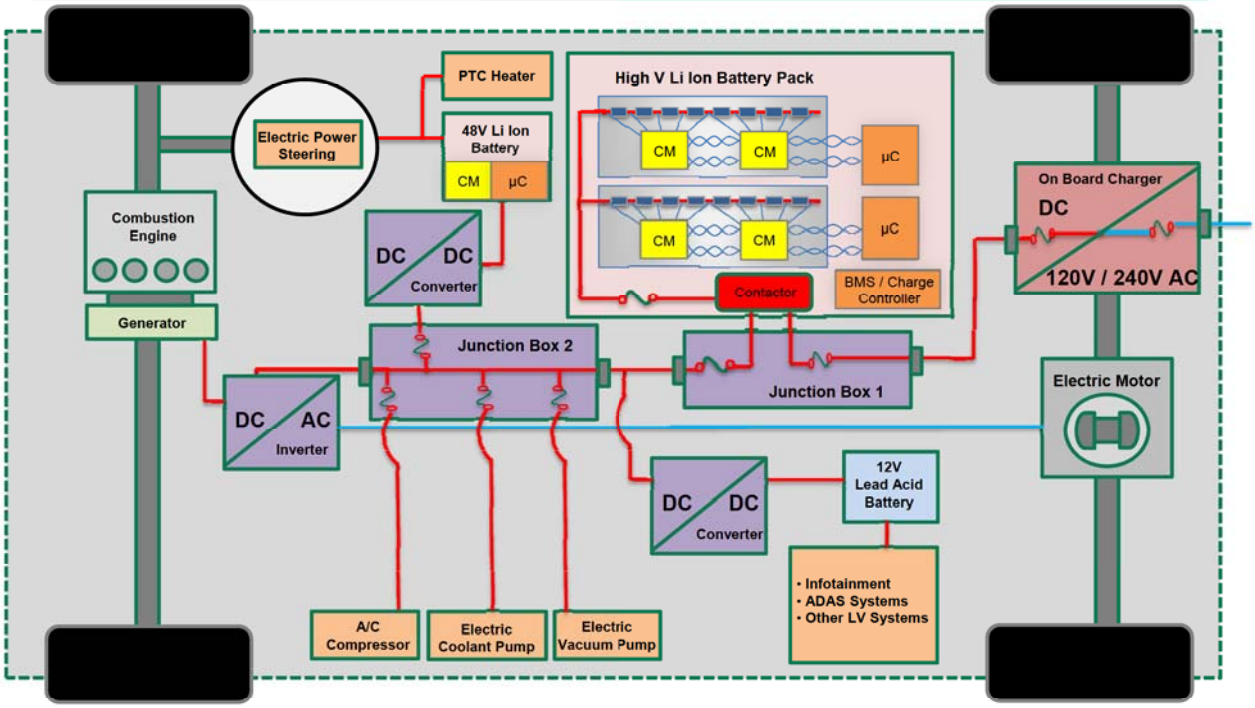
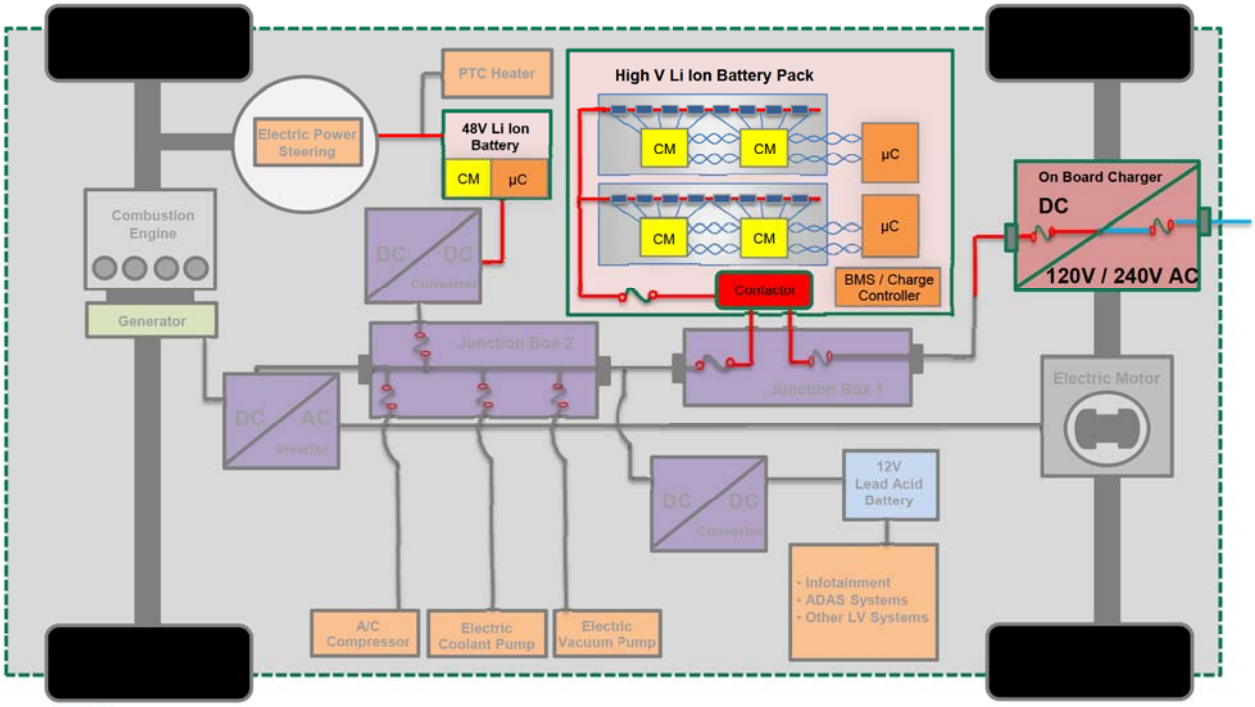


EV- / PHEV Architecture
电动汽车/插电式混合动力汽车架构
High Voltage Battery System and OBC
高电压电池系统和车载充电器系统



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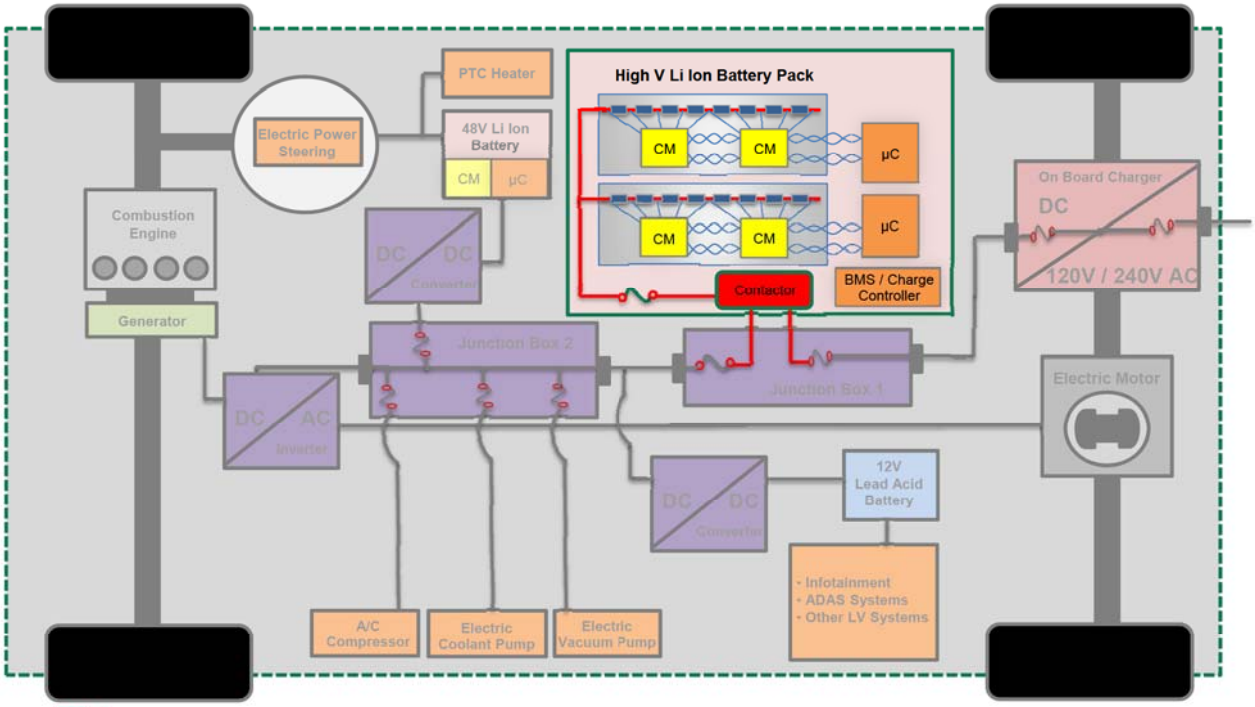
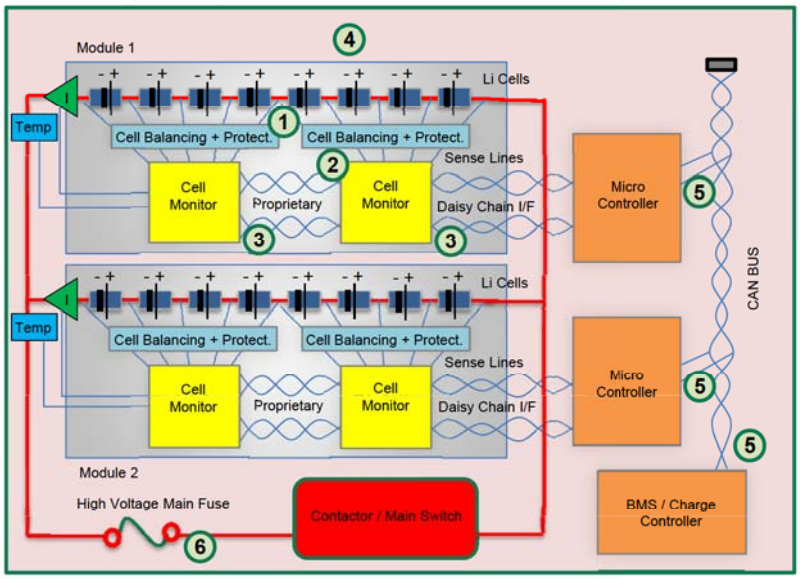
高电压电池系统



High Voltage Battery System
高电压电池系统
Building Blocks & Protection Needs
构件及保护需求

High Voltage Li Ion Battery Pack
高电压锂离子电池组



1. Sense Line Fuse to protect from shorting of Sense Lines
   对传感器线路进行短路保护的传感器线路保险丝
2. Cell Monitor IC Sense Line Input Overvoltage Protection
   电池监测集成电路传感器线路输入过电压保护
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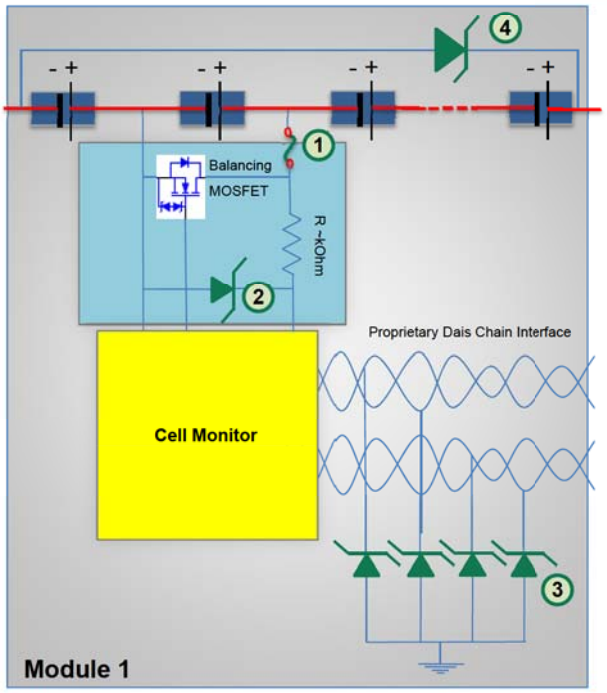
High Voltage Battery System
高电压电池系统
Sense Line & Cell Monitor Protection – Details
传感器线路及电池监测保护 – 详细说明



1. Sense Line Fuse to protect from shorting of Sense Lines.
对传感器线路进行短路保护的传感器线路保险丝：
• Depending on Battery System there can be 12 to ~200 Sense Lines per car
•根据电池系统，每辆车可能有 12 至 200 条传感器线路
• Shorting can theoretically happen between random sense lines depending on failure modes
•理论上在随机传感器线路之间都有可能发生短路，这取决于故障模式
• Potential Failures: Assembly Issues, Car Accident or Crash, Leakage of coolants or other liquids that can build conductive deposits
•可能发生的故障：装配问题，车祸或碰撞，能够形成导电沉积的冷却液或其他液体的泄露

2. Cell Monitor IC Sense Line Input Overvoltage Protection:
电池监测集成电路传感器线路输入过电压保护：
• Protects low voltage (5V) input terminals of Cell monitor from transients
•保护电池监测的低电压(5 V)输入端子免于瞬变损坏
• Hot Plug Transients occur during assembly and maintenance of battery pack; other transients can be induced from vehicle systems like charger, inverters, motor drives either via conduction or inductive coupling via adjacent cabling
•在电池组装配和保养过程中会发生热插拔瞬变；其他瞬变可能通过传导或电感耦合或通过相邻布线在诸如充电器、逆变器、电机驱动器的车辆系统中诱发

3. Overvoltage / ESD Protection for Daisy Chain I/F (e.g. Hot Plug, ESD)
菊链 I/F（如：热插拔、ESD）的过电压/ESD 保护

4. High Voltage TVS across Battery String for Transient Protection (e.g. Hot Plug)
整个电池串上的高电压 TVS 用于瞬变保护（如：热插拔）

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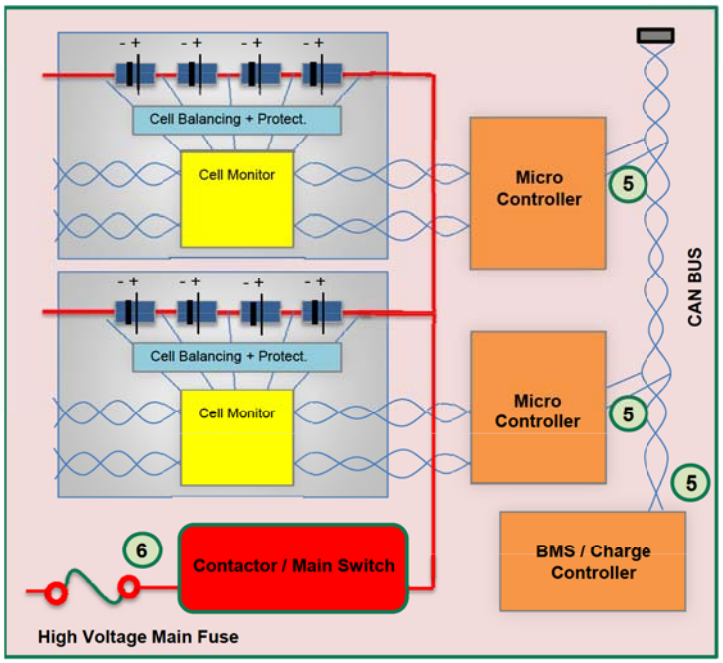
High Voltage Battery System
高电压电池系统
Microcontroller & Power Line Protection - Details



5. Overvoltage / ESD Protection for CAN Bus I/F:
CAN 总线 I/F 的过电压/ESD 保护：
• CAN Bus is the typical interface in order to link the Cell Monitoring Controllers to Higher Level BMS Controllers which then communicate with other controllers in the car
•CAN 总线是将电池监测控制器连接至随后与车内其他控制器通信的上级电池管理系统控制器的典型接口
• In the densely packed environment of a car battery system CAN lines can be subjected to overvoltage stress caused by ESD (e.g. during assembly & maintenance) or other transients introduced from other car systems via coupling or via conduction.
•在汽车电池系统的密集环境中，CAN 线会遭受应 ESD（例如在组装和保养时）或其他汽车系统通过耦合或传导而引起的其他瞬变所导致的过电压应力。

6. High Voltage / High Current fuse for power line protection :
用于电力线保护的高电压/高电流保险丝：
• The high voltage / high current main fuse is the last resort of safety in the case of excessive current or short circuit events in the high power system of the car
•高电压/高电流主保险丝是在汽车的大功率系统中发生过量电流或短路事件是保障安全性的最后手段
• Suitable fuses need to be well coordinated with other fuses being dowstream in the system (e.g. junction boxes)
•系统下游的保险丝应有合适的保险丝与之良好协调（例如：接线盒）
• Fuse needs to be able to withstand several thousand amps and need to be able to continuously conduct high amount of energy for a long time
•保险丝需要能够承受数千安培的电流，而且需要能够长时间持续传导较大的能量

High Voltage Li Ion Battery Pack
高电压锂离子电池组

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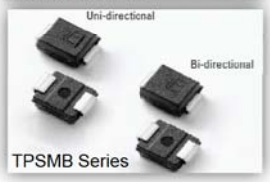
High Voltage Battery System
高电压电池系统
Littelfuse Protection Portfolio
力特保护方案系列

1 Sense Line Fuse Options* 传感器线路保险丝产品选择 *

2 Cell Monitor IC Input OV Protection 电池监测 IC 输入过电压保护

3 OV / ESD Protection for Daisy Chain I/F 菊链 I/F 过电压/ESD 保护

4 High Voltage TVS Transient Protection 高电压 TVS 瞬变保护



5 OV / ESD Protection for CAN Bus I/F CAN 总线 I/F 过电压/ESD 保护

6 High Voltage / Current Power Line Fuses 高电压/电流电力线保险丝

***Sense Line Fuses:**
***传感器线路保险丝:**
Sense Line Short Circuit Protection with electronic fuses can have very different requirements and not all fuses might be suitable. Littelfuse offers a variety of special tested electronic fuses for sense line applications. Please contact your Littelfuse sales or FAE for more details.
使用电子保险丝进行传感器线路短路保护具有非常不同的要求，并非所有保险丝都能适合。力特为传感器线路应用提供各种各样经过测试的特殊的电子保险丝。欲知详情，请联系力特销售或现场应用工程师。

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High Voltage Battery System
高电压电池系统
Littelfuse Protection Portfolio – Selection Criteria
力特保护方案系列 – 选择标准

1 Sense Line Fuse Options* 传感器线路保险丝产品选择 *

- Voltage range depends on battery configuration, same for interrupt rating
- 电压范围取决于电池组成，额定中断电流同样如此
- Fuse should have a low temperature de-rating
- 保险丝应具有较低的温度降额
- Low tolerance of cold resistance as well as long term stability is required
- 要求具有耐冷性低耐受以及长期可靠性
- Fuse should be able to cope with temperature cycles and vibrations
- 保险丝应能应对温度循环和振动
- Small Formfactor
- 小封装
- Ideally fulfills AEC-Q test conditions
- 完美满足 AEC-Q 测试条件要求
- LF recommended: 453 Series, 462 Series, 437 Series, (505 Series)
- 力特推荐：453 系列，462 系列，437 系列（505 系列）

2 Cell Monitor IC Input OV Protection 电池监测 IC 输入过电压保护

3 OV / ESD Protection for Daisy Chain I/F 菊链 I/F 过电压/ESD 保护

- 5V Operating Voltage seems to be most common
- 5V 工作电压似乎是最常见的
- Low Capacitance is desirable
- 低电容是理想的
- Silicon Diode Arrays provide fastest protection and lowest clamp voltages
- 硅二极管阵列提供最快的保护和最低的钳位电压
- Small Formfactors of 0402 to 0603
- 小尺寸封装（0402、0603）
- Power Capability several 10 to several 100W (8/20µs)
- 功率能力，数十瓦至数百瓦（8/20µs）
- AEC-Q101 qualified
- 符合 AEC-Q101 测试要求
- LF recommended: SP3030, SP4021
- 力特推荐：SP3030，SP4021

4 High Voltage TVS Transient Protection 高电压 TVS 瞬变保护

- Voltage range depends on battery configuration
- 电压范围取决于电池组成
- Power requirements depend on transient environment and battery configuration
- 功率要求取决于瞬变环境和电池组成
- LF offers 600W up to 3000W Diodes
- 力特提供 600 W 至 3000 W 二极管
- AEC-Q101 qualified
- 符合 AEC-Q101 测试要求
- Small Formfactor like TPSMA6L (Low Profile 600W Diode)
- 小尺寸封装，如 TPSMA6L（低剖面 600 W 二极管）
- LF recommended: TPSMA6L, TPSMB
- 力特推荐：TPSMA6L、TPSMB

5 OV / ESD Protection for CAN Bus I/F CAN 总线 I/F 过电压/ESD 保护

- Typical operating voltage of CAN Bus protectors is 24V
- CAN 总线保护的典型工作电压为 24V
- Power rating between 200W to 500W
- 功率额定值在 200W 至 500W 之间
- ESD Contact Capability of 30kV recommended
- 建议的 ESD 接触放电处理能力为 30kV
- Low capacitance between 11 to 30pF
- 位于 11 至 30pF 之间的低电容
- AEC-Q101 qualified
- 符合 AEC-Q101 测试要求
- Small Formfactor Packages SOD882 or SOT23-3 (2 channels)
- 小尺寸封装封装 SOD882 或 SOT23-3（2 通道）
- LF recommended: SM24CANA, SM24CANB, SPHV-C Series
- 力特推荐：SM24CANA、SM24CANB、SPHV-C 系列

6 High Voltage / Current Power Line Fuses 高电压/电流电力线保险丝

- Operating voltage up to 450VDC
- 工作电压高达 450VDC
- Low current fuse ratings 10A to 30A, 40A (425VDC)
- 低保险丝电流额定值 10A 至 30A，40A（425VDC）
- Medium current ratings 60A to 125A
- 中等电流额定值 60A 至 125A
- High current ratings 150A to 250A
- 高电流额定值 150A 至 250A
- Form Factors 10x38, 42x20, 52x30
- 形状因数 10x38, 42x20, 52x30
- High Interrupt Rating of 10kA
- 高中断电流额定值 10kA
- Various mounting options: board mount, bolt down, blade, inline cable
- 多种安装选项（板式、插销式、刀片式、内联线缆）
- LF recommended: 0HEV Series (available) Medium / High Current Versions under development
- 力特推荐：0HEV 系列（可供选用）中/高电流版本正在研发
- Following ISO8820-8 Requirements
- 符合 ISO8820-8 标准要求

***Sense Line Fuses:**
***传感器线路保险丝:**
Sense Line Short Circuit Protection with electronic fuses can have very different requirements and not all fuses might be suitable. Littelfuse offers a variety of special tested electronic fuses for sense line applications. Please contact your Littelfuse sales or FAE for more details.
使用电子保险丝进行传感器线路短路保护具有非常不同的要求，并非所有保险丝都能适合。力特为传感器线路应用提供各种各样经过测试的特殊的电子保险丝。欲知详情，请联系力特销售或现场应用工程师。

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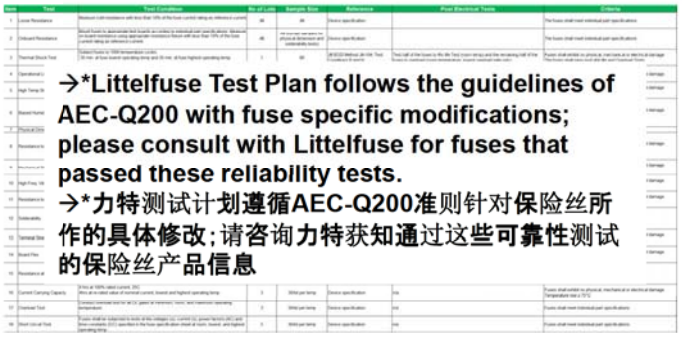
Littelfuse Electronic Fuses Qualification Testing
力特电子保险丝认证测试
Reliability Testing for Electronic Fuses in Automotive Apps
汽车应用电子保险丝的可靠性测试

- More Automotive Applications like e.g. Battery Sense Line Protection rely on electronic fuses
- 更多的汽车应用(如电池传感器线路保护)依赖电子保险丝
- There are no official standards that define the qualification of electronic fuses for use in Automotive
- 在汽车中使用的电子保险丝没有定义认证的官方标准
- Littelfuse has developped a test plan following AEC-Q200 guidelines to test fuses for their suitability and reliability for Automotive Applications
- 力特根据 AEC-Q200 准则制定了一项测试计划，对保险丝对汽车应用的适用性和可靠性进行测试
- Test Plan contains18 test cases like 1000hrs op life, temperature cycling, elevated temp testing, vibration testing etc. and uses increased sample quantities
- 这项测试计划包含 18 项测试，例如 1000 小时工作寿命、温度循环、升高温度测试、振动测试等，所用的样本量也有所增加
- Littelfuse is continuously adding part numbers and ratings to the Automotive qualified range of electronic fuses
- 力特不断在汽车应用电子保险丝的合格范围内提供丰富的产品

Fuses for Battery Sense Line Applications	Voltage Rating	Current Rating	Interrupt Rating	Size	Type
0453.630MR	32VDC / 125VDC	630mA	300A / 50A @ rated voltage	6 x2.7mm	NANO
0437002.WRA	63VDC	2A	50A @ r	mm	CCF
0437.750WRA	63VDC	750m		nm	CCF
46206300000	250VDC / 350V			0.5x4.5x4.5mm	NANO

Automotive Grade*
汽车级*



→*Littelfuse Test Plan follows the guidelines of AEC-Q200 with fuse specific modifications; please consult with Littelfuse for fuses that passed these reliability tests.
→*力特测试计划遵循AEC-Q200准则针对保险丝所作的具体修改;请咨询力特获知通过这些可靠性测试的保险丝产品信息

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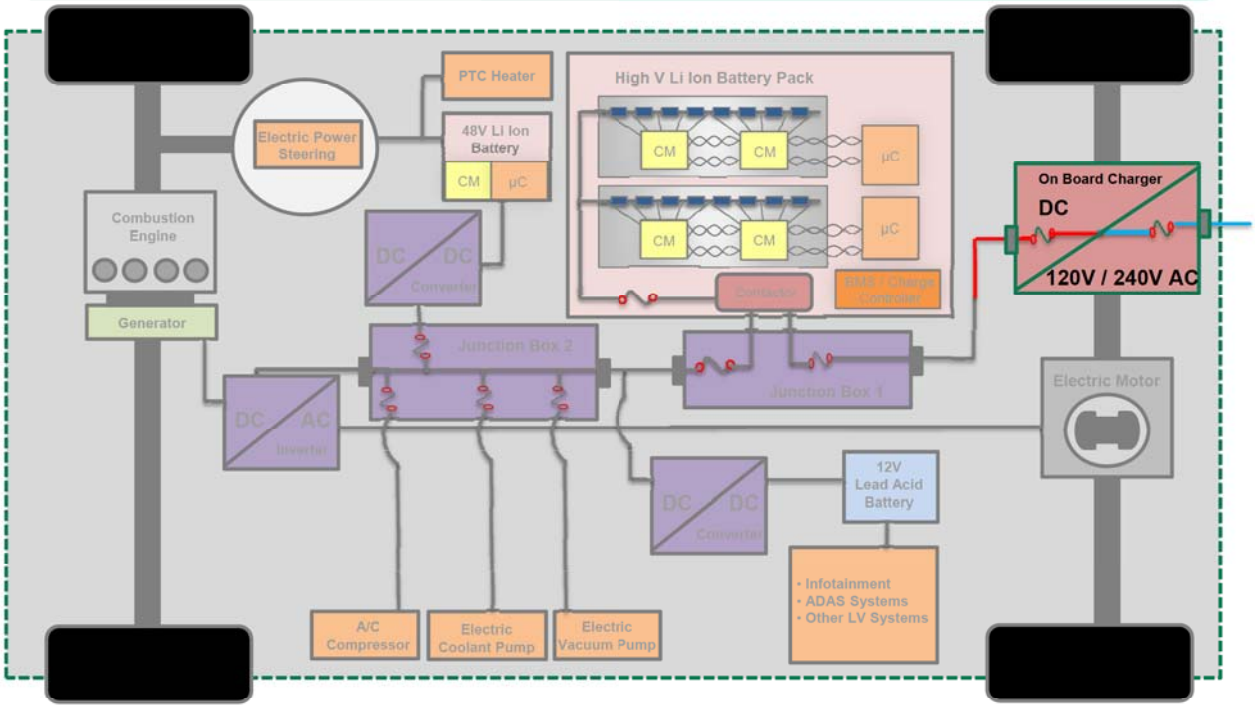
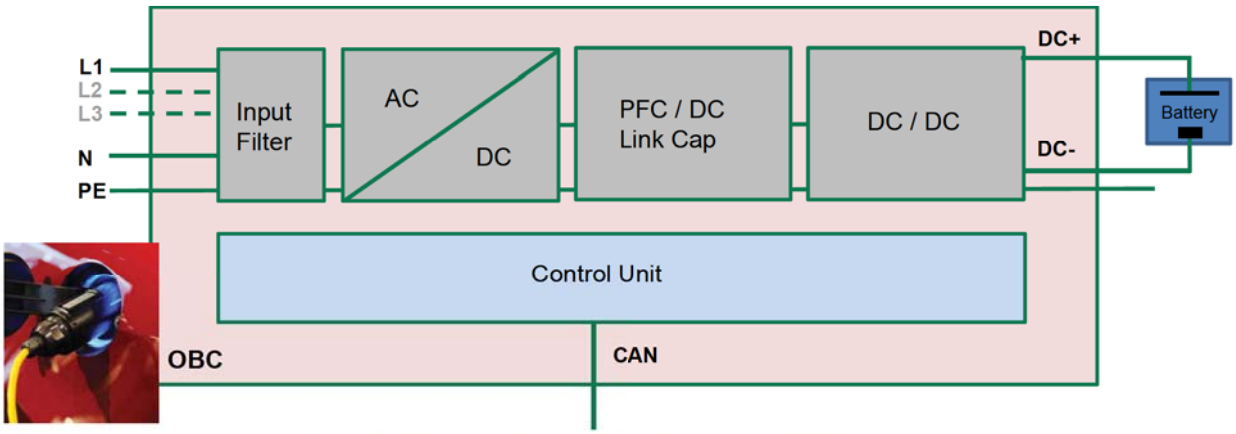
EV- / PHEV Architecture
电动汽车/插电式混合动力汽车架构
OBC (On Board Charger System)
OBC(车载充电器系统)

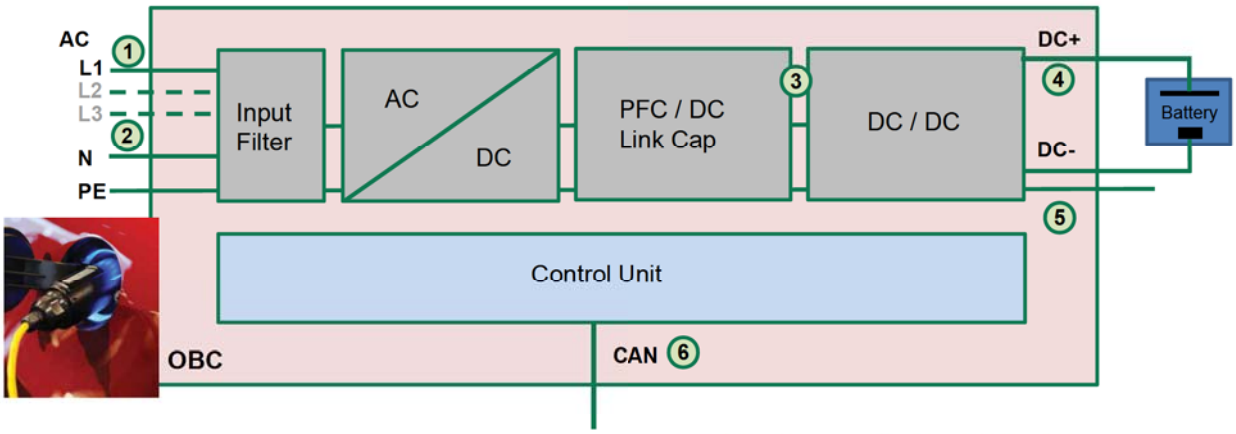


On Board Charger System (OBC)
车载充电器系统(OBC)
Basic Architecture and Advantages
基本架构与优点



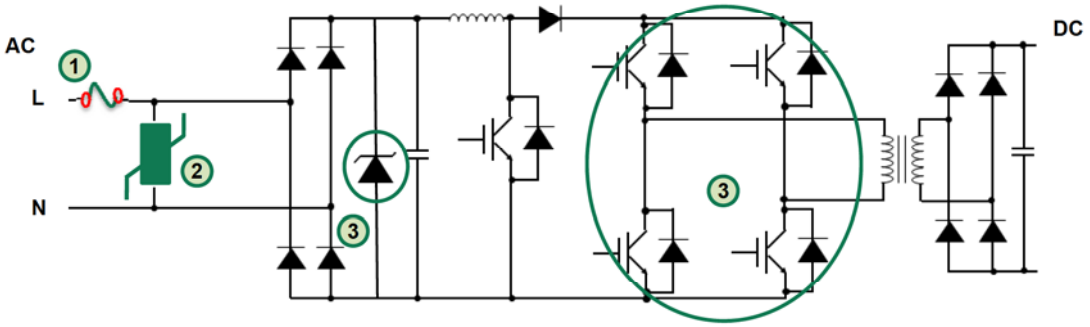
- On Board Chargers are used for Level 1 and 2 Charging Stations that provide a connection to the AC Grid
- 车载充电器用于可与交流电网进行连接的 1 级和 2 级充电站
- Charging functionality is built into an On Board Charger which provides all functionality for converting AC to DC as well as controlling the charging process in a battery friendly way
- 充电功能内置进车载充电器内，车载充电器提供交流到直流转换以及以电池友好的方式控制充电过程的所有功能
- AC charging is quite cost efficient and provides no or only minor adjustments to the available electrical infrastructure at home or in the public space
- 交流充电非常具有成本效益，对家中或公共场所可用的电力基础设施没有或只有很小的调整要求
- AC Supply ranges from 110VAC (1 Phase) up to 480VAC (3 Phase), depending on region; DC Output is typically in the range of 300VDC to 400VDC and higher
- 交流供电范围从 100VAC(单相)到高达 480VAC(三相)，取决于所在地区；直流输出通常在 300VDC 到 400VDC 之间，也有可能更高

On Board Charger System (OBC)
车载充电器系统(OBC)
Protection Needs
保护需求



1. AC Input Line(s) – Require Fuses for Over Current Protection
   交流输入线 – 需要保险丝进行过电流保护
2. AC Input Line(s) – Require MOV (and GDT) for Transient Protection
   交流输入线 – 需要 MOV(和 GDT)进行瞬变保护
3. DC Link Capacitors and IGBT Over Voltage Protection
   直流环节电容和 IGBT 过电压保护
4. High Voltage DC Link – Requires Fuses for Over Current Protection
   高压直流环节 – 需要保险丝进行过电流保护
5. High Voltage DC Link – MOVs for Over Voltage Protection
   高压直流环节 – 使用 MOV 进行过电压保护
6. CAN Bus – ESD and Transient Protection required
   CAN 总线 – 需要进行 ESD 和瞬变保护

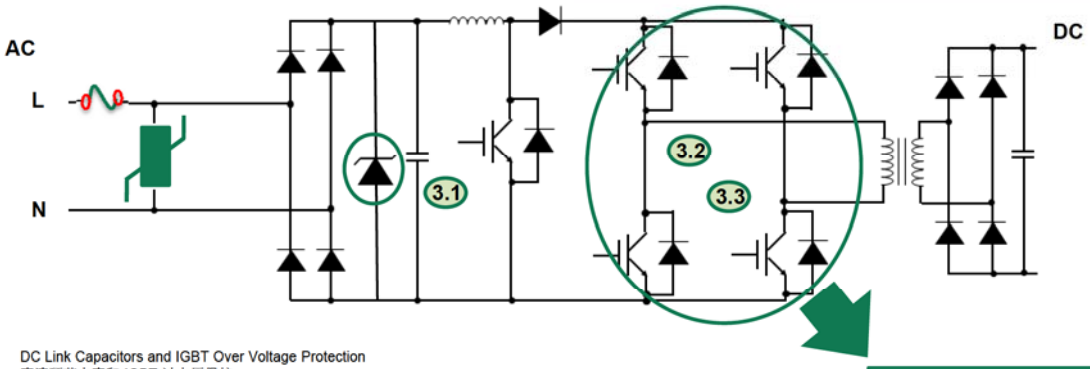
On Board Charger System (OBC)
车载充电器系统(OBC)
Protection Needs – Details
保护需求 – 详细说明



1 AC Input Line(s) Fuses:
交流输入线保险丝:
Requires Automotive Grade Fuses for Over Current Protection that can conduct high currents (e.g. 16A, 32A) at voltages up to 250VAC single phase; high interrupt rating and ability to withstand vibrations, surge transients and thermal cycles are key.
需要能够在高达 250VAC(单相)电压下传导高电流(如16A、32A)的汽车级保险丝进行过电流保护;高中断电流额定值及耐振动、浪涌瞬变和热循环的能力是关键。

2 AC Input Line(s) Transient Protection:
交流输入线瞬变保护:
Due to the direct connection to the power grid transient (8/20µs) protection with MOVs and GDTs is required; the MOVs used need to work at elevated temperatures (125° C) and need to offer AC line working voltages. AEC-Q200 approval is a must have.
由于与电网直接连接, 需要使用 MOV 和 GDT 进行瞬变保护(8/20µs);所用的 MOV 需要能够在升高的温度(125° C)条件下工作, 并且需要提供交流线的工作电压。AEC-Q200 标准认可是必须。

On Board Charger System (OBC)
车载充电器系统(OBC)
Protection Needs – Details 2
保护需求 – 详细说明 2

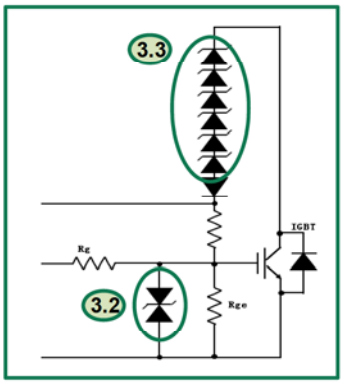


3 DC Link Capacitors and IGBT Over Voltage Protection
直流环节电容和 IGBT 过电压保护

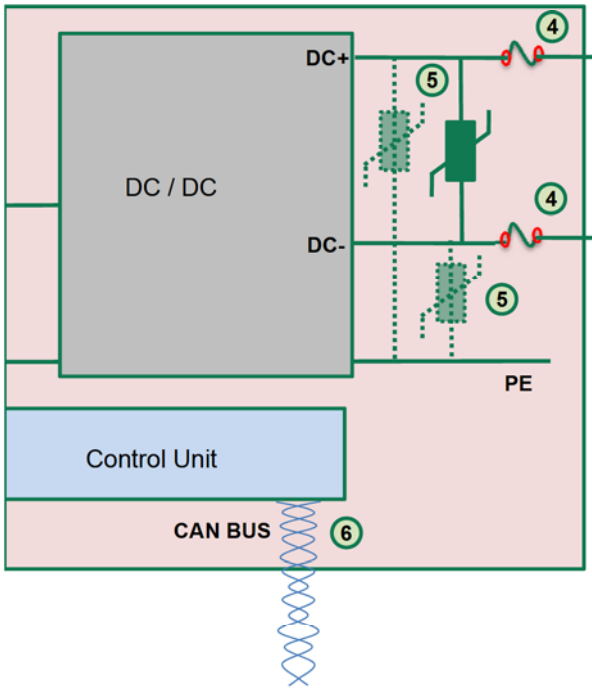
3.1 DC Link Capacitor Protection: Even though DC Link Capacitors are intended to filter certain transients they still might need protection in certain cases; fast acting Auto Grade TVS Diodes can protect these costly parts
直流环节电容保护:即使直流环节电容旨在过滤特定的瞬变, 在某些情况下可能依然需要保护;快速动作的汽车级 TVS 二极管能够保护这些昂贵的部件

3.2 IGBT Gate Overvoltage Protection: IGBT Gate requires protection for Over Voltage Spikes; in former times Zener Diodes were used but these do not provide the same advantages as TVS Diodes like fast response, higher surge capability and better reliability.
IGBT 门过电压保护:IGBT 门需要针对过电压尖峰进行保护;过去使用的是齐纳二极管, 但是它们无法提供与 TVS 二极管相同的优势, 如:快速响应、更高的浪涌能力和更高的可靠性。

3.3 IGBT Collector Emitter Inrush and Overvoltage Protection: Stacked TVS Diodes allow to protect the C-E high voltage side of IGBTs from harmful inrush and Over Voltage Transients
IGBT 集电极发射极突波和过电压保护:使用堆栈式 TVS 二极管可以对 IGBT 的 C-E 高电压侧进行保护, 使之免受有害突波和过电压瞬变的危害



On Board Charger System (OBC)
车载充电器系统(OBC)
Protection Needs – Details 3
保护需求 – 详细说明 3



4 High Voltage DC Link Over Current Protection: Helps to clear dangerous short circuit conditions that can be caused due to faults in the OBC or Battery Pack or by external events like a car accident
高压直流环节过电流保护:有助于消除因车载充电器或电池组的故障或外部事件(如车祸)而可能导致的危险的短路情况

5 High Voltage DC Link Over Voltage Protection: Clears overvoltage transients that can be introduced by switching actions (hot plug) or that are introduced by other systems of the car
高压直流环节过电压保护:清除开关动作(热插拔)所引起的或应汽车的其他系统所引起的过电压瞬变

6 CAN Bus – ESD and Transient Protection:
CAN 总线 – ESD 和瞬变保护:
The OBC communicates via CAN Bus with other systems like the BMS. In the densely packed environment of a car CAN lines can be subjected to overvoltage stress caused by ESD (e.g. during assembly & maintenance) or other transients introduced from other car systems via coupling or via conduction.
车载充电器通过 CAN 总线与其他系统(如电池管理系统)进行通信。在密集的汽车环境中, CAN 线路会遭受 ESD(在组装和保养时)或其他汽车系统通过耦合或传导而引起的其他瞬变所导致的过电压应力。

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On Board Charger System (OBC)
车载充电器系统(OBC)
Littelfuse Protection Portfolio – Selection Criteria
力特保护方案系列 – 选择标准

1 AC Input Line(s) Fuses 交流输入线保险丝

- Operating Voltage up to 275VAC
- 工作电压高达 275VAC
- Operating Current 50A
- 工作电流为 50A
- High Interrupt Rating of 10kA
- 10kA的高额定中断电流
- Form Factor 10x38mm with different mounting options: board mount, blade, bolt down, inline cable
- 形状因数 10X38mm, 具有不同的安装选择:板式、刀片式、插销式、内联线缆
- Automotive Grade: Following ISO8820-8 Requirements being able to cope with temperature cycling, vibration and surge transients
- 汽车级:符合 ISO8820 8 要求, 能够应对温度循环、振动和浪涌瞬变

2 AC Input Line(s) Transient Protection 交流输入线瞬变保护
5 High Voltage DC Link Over Current Protection 高压直流环节过电流保护

- Operating Voltage range of HMOV from 14VDC up to 825VDC and 11VAC to 625VAC addresses complete voltage range seen in most automotive applications (like OBC)
- HMOV 的工作电压范围在 14VDC 到高达 825VDC 及 11VAC 到 625VAC 之间, 涵盖大多数汽车应用的完整电压范围(如 OBC)
- 10, 14 and 20mm Disc Sizes with Surge Capability up to 10000A (8/20µs)
- 10、14 和 20mm 盘大小, 浪涌能力高达 10000A(8/20µs)
- Double Layer coating provides high electrical isolation capability of 2500V
- 双层土层提供 2500V 的高电绝缘能力
- Max operating temp 125° C
- 最大工作温度 125° C
- AEC-Q200 qualified
- 符合 AEC-Q200 测试要求
- Certified acc. to IEC 60950-1 (Annex Q) and UL1449
- 根据 IEC 60950-1(附录 Q)及 UL1449 标准认证

3 DC Link Capacitors and IGBT Over Voltage Protection 直流环节电容和 IGBT 过电压保护

- Voltage range of TVS depends on TVS series, ranges from 5V to 85V available, higher stand off voltages can be realized by putting several diodes in series
- TVS 的电压范围取决于 TVS 系列, 在 5V 到 85V 之间, 通过串联多个二极管可实现更高的反向断态电压
- Power requirements depend on transient environment
- 功率要求取决于瞬变环境
- LF offers 600W (TPSMA6L , TPSMB), 1500W (TPSMC) and 3000W (TPSMD) Diodes
- 力特提供 600W(TPSMA6L、TPSMB), 1500W(TPSMC)和 3000W(TPSMD)二极管
- AEC-Q101 qualified, PPAP available
- AEC-Q101 测试合格, PPAP 可用
- Small Formfactor like TPSMA6L (Low Profile 600W Diode)
- 小封装, 如 TPSMA6L (低剖面 600W 二极管)
- Max operating temp 150° C or 175° C
- 最大工作温度 150 或 175 度


TPSMD Series

4 High Voltage DC Link Over Current Protection 高压直流环节过电流保护

- Operating voltage up to 450VDC
- 工作电压高达 450VDC
- Low current fuse ratings 10A to 30A, 40A (425VDC)
- 低电流保险丝额定值 10A 至 30A, 40A(425VDC)
- Medium current ratings 60A to 125A
- 中度电流额定值 60A 至 125A
- High current ratings 150A to 250A
- 高电流额定值 150A 至 250A
- Form Factors 10x38, 42x20, 52x30
- 形状因数 10x38, 42x20, 52x30
- High Interrupt Rating of 10kA
- 高中断电流额定值 10k
- Various mounting options: board mount, bolt down, blade, inline cable
- 不同的安装选择:板式、刀片式、插销式、内联线缆
- LF recommended. 0HEV Series (available) Medium / High Current Versions under development
- 力特推荐:0HEV 系列(可供)中度/高电流版本正在研发中
- Following ISO8820-8 Requirements
- 符合 ISO8820-8 标准要求

6 CAN Bus – ESD and Transient Protection CAN 总线 – ESD 和 瞬变保护

- Typical operating voltage of CAN Bus protectors is 24V
- CAN 总线保护器的典型工作电压为 24V
- Power rating between 200W to 500W
- 额定功率在 200W 至 500W 之间
- ESD Contact Capability of 30kV recommended
- 建议的 ESD 接触放电能力为 30kV
- Low capacitance between 11 to 30pF
- 11至30pF的较低电容
- AEC-Q101 qualified
- 符合 AEC-Q101 测试要求
- Small Formfactor Packages SOD882 or SOT23-3 (2 channels)
- 小尺寸封装封装 SOD882 或 SOT23-3(2 通道)
- LF recommended: SM24CANA, SM24CANB, SPHV-C Series
- 力特推荐:SM24CANA、SM24CANB、SPHV-C 系列

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Summary and Conclusion
归纳与总结

- The Market for Vehicles using any kind of electric, battery powered drive system with voltages equal or higher than 48V is expected to grow double digit in the next years

  未来几年，采用电压等于或大于 48V 的任何电池动力驱动系统的汽车的市场预计将出现两位数的增长。
- Lithium based battery technology will be the basis for any kind of xEV Vehicles, besides its advantages of power density and charging cycle life it requires high efforts in monitoring and protection
  锂电池技术将是任何类型电动汽车的基础；除了在功率密度和充电循环寿命上的优势，在监测和保护上要求付诸较大努力
- Battery Management Systems in xEV Vehicles are highly complex and mission critical systems that need properly placed and selected protection components for overvoltage and short circuit protection

  任何类型电动汽车的电池管理系统都是高度复杂和任务关键性系统，需要精心选择和正确放置的保护元件进行过电压和短路保护
- Electronic Fuses for usage in Vehicle Systems like BMS Sense Line Protection need to be selected carefully and should be able to pass reliability testing following the AEC-Q guidelines; consultation with fuse experts from LF is essential
  在诸如电池管理系统传感器线路保护的车辆系统中使用的电子保险丝需要慎重选择，并应能够通过按照 AEC-Q 准则进行的可靠性测试；咨询力特的保险丝专家是有必要的
- On Board Charger Systems provide a cost efficient charging solution from the standard AC power grid, matching specific needs of the various battery architectures
  车载充电器系统提供了一种从标准 AC 电网进行充电的具有成本效益的解决方案，满足了各种电池架构的具体需求
- On Board Charging Systems link closely with the BMS system of a Vehicle and require also a high level of short circuit and overvoltage protection for AC as well as DC power systems, meeting Automotive Grade Reliability Expectations in terms of temperature, vibration and transient robustness
  车载充电系统与车辆的电池管理系统紧密联系，同样需要对交流和直流电源系统进行较高水平的短路和过电压保护，以在温度、振动和瞬变鲁棒性方面满足汽车级可靠性预期。

Thank you for your attention! Any questions?
感谢您的关注！有问题吗？

https://www.speed2design.com/education-center/circuit-protection-for-automotive-applications/

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