Littelfuse
Expertise Applied | Answers Delivered

Electric Vehicles
Charging and Battery Management System

Electric Car Charging Solution

AC Charging (Slow Charge):

- **Level 1:** 120V, Single phase 2kW and below
  – Typically takes 8–12 hours to charge fully depleted battery
- **Level 2:** 208-204V, Single phase (3, 3kW~20kW)
  – Requires a 40A circuit; takes 4–6 hours typically to charge up fully depleted battery
- **Level 3:** 380V, 3-phase (~20kW)
  – Requires a 30A circuit; takes 4–6 hours typically to charge up fully depleted battery

DC Charging (Quick Charge):

- **INPUT:** 480VAC, 3-phase
- **OUTPUT:** 500VDC/1000V, 200A+, 100kW+
- Typically provides 80% charge within 30 minutes

Two/Three Wheeler

Onboard Charger:
- SiC/IGBT Power Devices
- TMOV/MOV/TVS • Fuses
- NTC for Temperature Sensing

Power Distribution Unit:
- Boltdown fuses
- Blade Fuses

Battery Pack:
- SMD Fuse: 881 Series
- Boltdown Fuse: BF1
- NTC for Temperature Sensing

Lighting:
- TPSMB/TPSMC TVS
- AUMLA – SMD MOV

BMS:
- Fuses: Senseline & Cell
- SPxx, TVS for OV/ESD
- CAN Bus protection
- NTC for Temperature Sensing

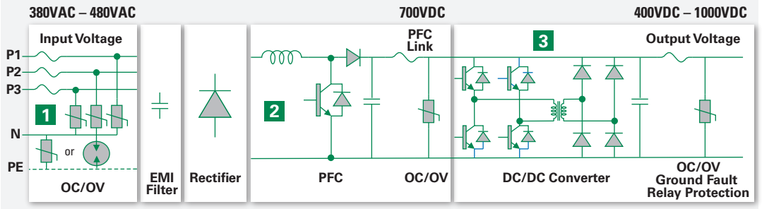
ECU/Motor Drive:
- SLD/TPSMB TVS diode
- Power Mosfets, rectifier diodes
- Hall Effect, TMR & NTC Sensors

Mobile Charger:
- TPSMB TVS diode
- SMDC: Resettable Fuse

Cluster:
- TPSMB TVS diode
- SMDC: Resettable Fuse

Side Stand:
- Sensor (Reed Switch)

Charging Solution Block Diagram



1 AC Input Line(s) Transient Protection

- **JLS, LDC Series** — UL Listed AC Fuse
- **504, 505, 606 Series** — AC Fuse for Modular Architecture
- **CG3 Series** — Gas Discharge Tube
- **AUMOV, TMOV** — Varistors
- **PxxOMEL Series** — SIDACtor® Device
- **Active Rectification** — Switching Thyristor

2 Front End PFC Converter

- **LSIC2SD, LSIC1MO, DUR Series** — SiC Diode, MOSFET and IGBT
- **L70QS, PSR, 525 Series** — DC Fuse
- **AUMOV, TMOV** — Varistors
- **SMBJ, SMCJ Series** — TVS Diode

3 High Voltage DC-DC Converter

- **LSIC2SD, DUR Series** — SiC Diode or Ultrafast Diode for Modular Architecture
- **L70QS, PSR, 505, & 525 Series** — DC Fuse for Modular Topology
- **LSIC1MO, MG12 Series** — IGBT Module or SiC MOSFET
- **AUMOV, TMOV** — Varistors
- **PGR Series** — Ground Fault Protection Relay
- **SMBJ, SMCJ Series** — TVS Diode

BMS and Safety Standards

FMVSS 305:

- **Described:**
  Retention of propulsion battery protection during a crash
  Electrical isolation of chassis from high-voltage system

BMS Need to meet ASIL C or D

ASIL C or D
Automotive Safety integrity level

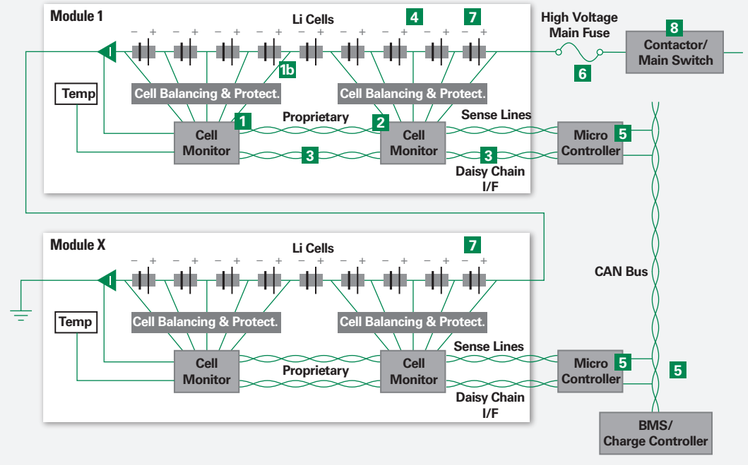
→ Protection for the signal line harness

ISO26262
Functional safety for automotive electronics and electrical safety-related systems

To meet ISO26262 in BMS:

- Single Multiple points of failures must be considered
- Sensing line fuse disconnect the cells from the BMS board, when short circuit occurs due to components failure or dendrite growth on PCB.

Battery Management System Block Diagram



Overcurrent Protection

- **1 — 437, 438, 440, 441, 501, 881 Series** — Sense line fuse to protect against shorting of sense lines
- **1b — 251, 275 Series** — Fuse in line with wire
- **6 — 525, 881, HEV Series** — High voltage/high current fuse for power line protection
- **6 — 885 Series** — High DC Voltage fuse for power line protection

Overvoltage Protection

- **2 — TPSMA6L, SD05 Series** — Cell monitor IC Sense line input overvoltage protection
- **3 — TPSMB, TPSMC Series** — Overvoltage/ESD protection for daisy chain I/F
- **4 — TPSMB Series** — High voltage TVS across battery string for transient protection
- **5 — SM24CANx Series** — Overvoltage/ESD protection for CAN Bus I/F

Sensing Products

- **7 — Thermal Sensors** — For battery temperature monitoring
- **8 — Reedswitch/Hall based Sensing Assemblies** — For battery swapping