



MERSEN SOLUTIONS FOR EV / HEV

November 2020



MERSEN IN BRIEF

A FRANCE-HEADQUARTERED TRADED COMPANY WITH GLOBAL POSITIONS

SALES

€950M

STAFF

7,000

GEOGRAPHIES

- 33 % NORTH AMERICA
- 34 % EUROPE
- 33 % ASIA AND ROTW

ADVANCED MATERIALS

**ANTICORROSION
EQUIPMENT**

World's no. 1-2 in
graphite equipment



**GRAPHITE
SPECIALTIES**

World's no. 1-2 in
high-temperature
applications



**POWER TRANSFER
TECHNOLOGIES**

World's no. 1-2 in
brushes for
industrial motors



ELECTRICAL POWER

**ELECTRICAL
PROTECTION & CONTROL**

World's no. 2 in
industrial fuses



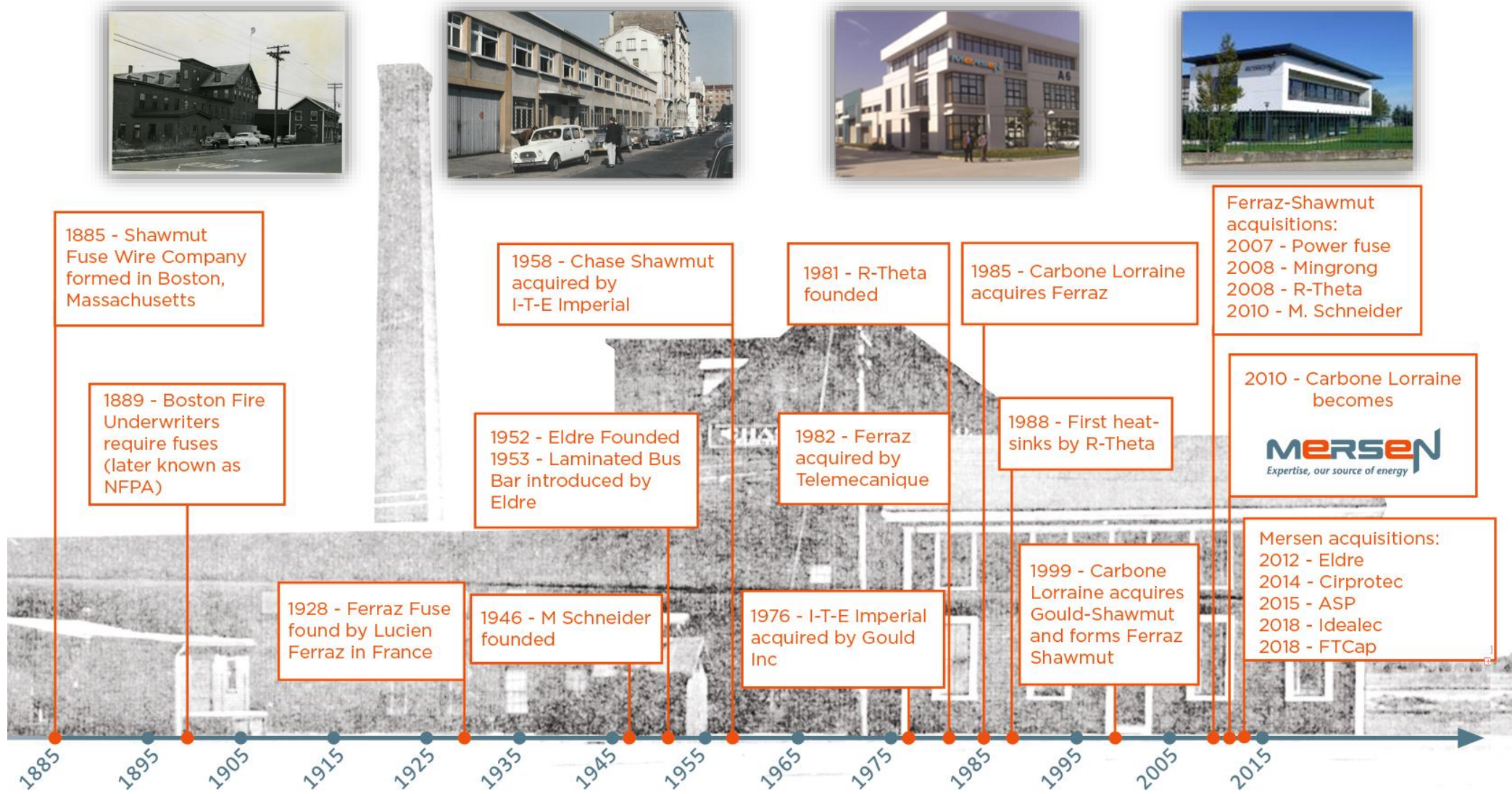
**SOLUTIONS FOR
POWER MANAGEMENT**

World's no. 2 in
passive components for
power electronics



* As of December 31, 2019

OVER 130 YEARS OF EXPERIENCE



SPM PRODUCT PORTFOLIO

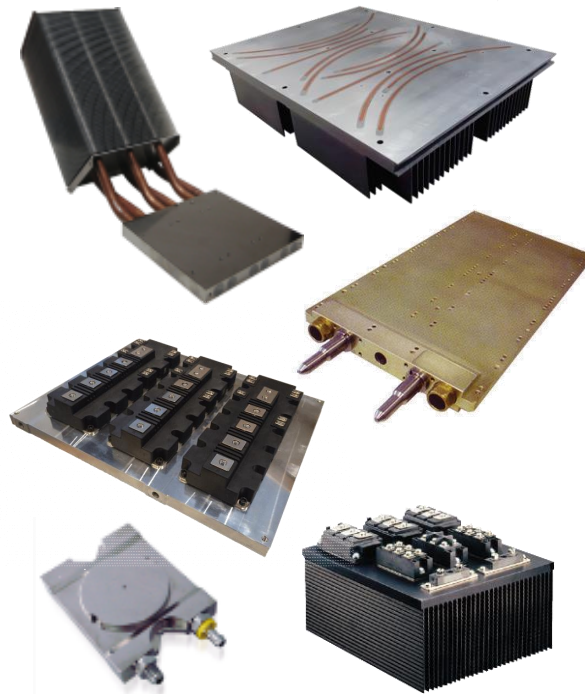
HIGH-SPEED FUSE AND HYBRID PYRO-FUSE

- UL Round and Square Body
- British Standard AC Protection
- IEC Cylindrical and Square Body (French / DIN)
- AC Low and Medium Voltage
- DC Rated For Traction
- DC protection for EV and EES



COOLING SOLUTIONS

- Air and Liquid Cooled Heatsinks
- Embedded Heat-Pipe Heatsinks
- Heat-pipe Assemblies



BUS BAR

- Laminated / Multi-layer
- Flexible / High T° / Low L
- Battery cell connection
- Powder Coated



CAPACITORS



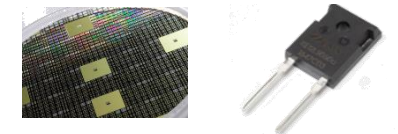
- Customized capacitors:
 - Film
 - Electrolytic
 - Sub-assembly



SIC SEMICONDUCTORS



- Protection devices
- Custom designs



MERSEN SOLUTIONS FOR POWER MANAGEMENT

A GLOBAL AND DEDICATED MANUFACTURING FOOTPRINT

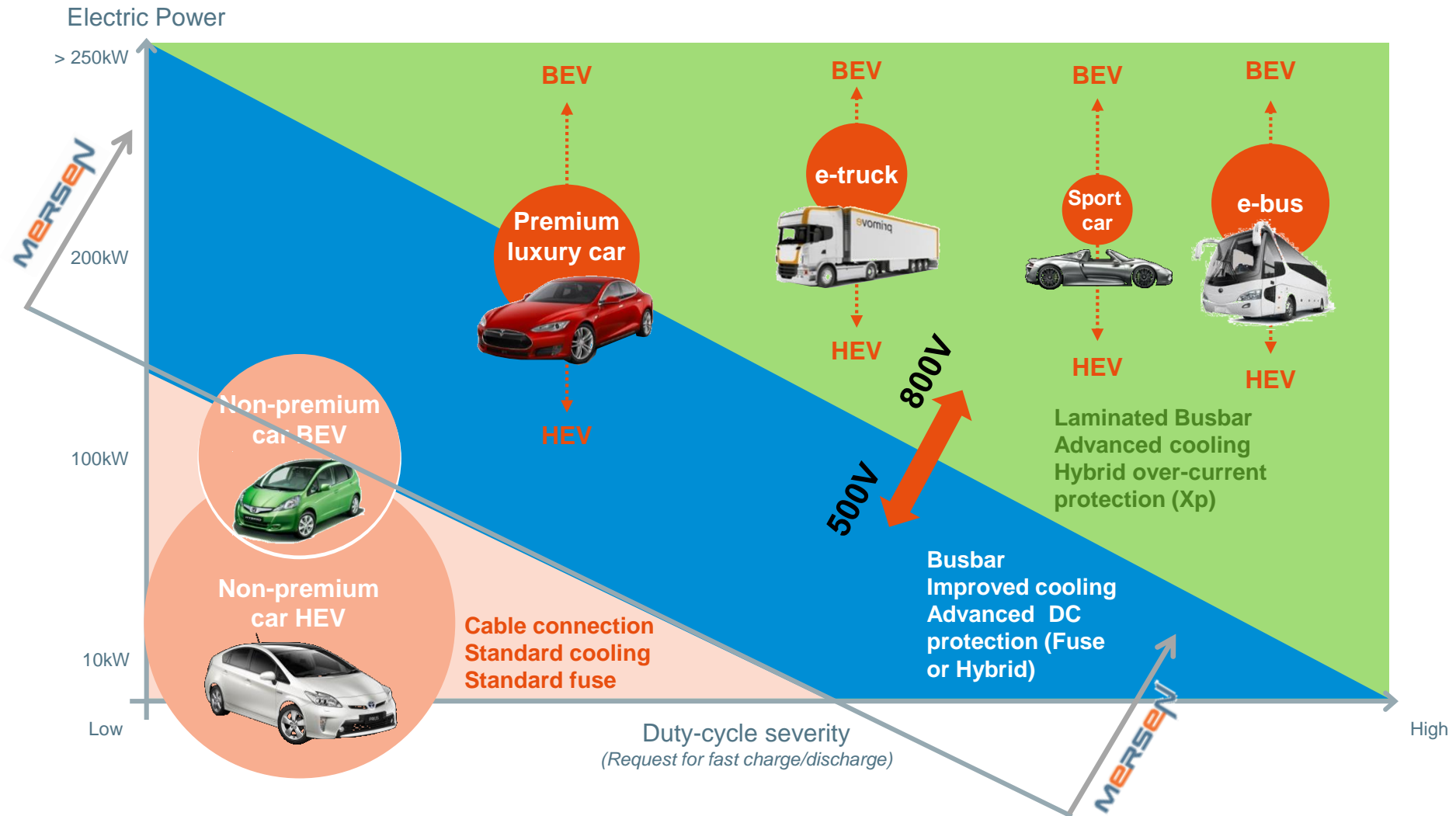


MERSEN SOLUTIONS FOR EV/HEV

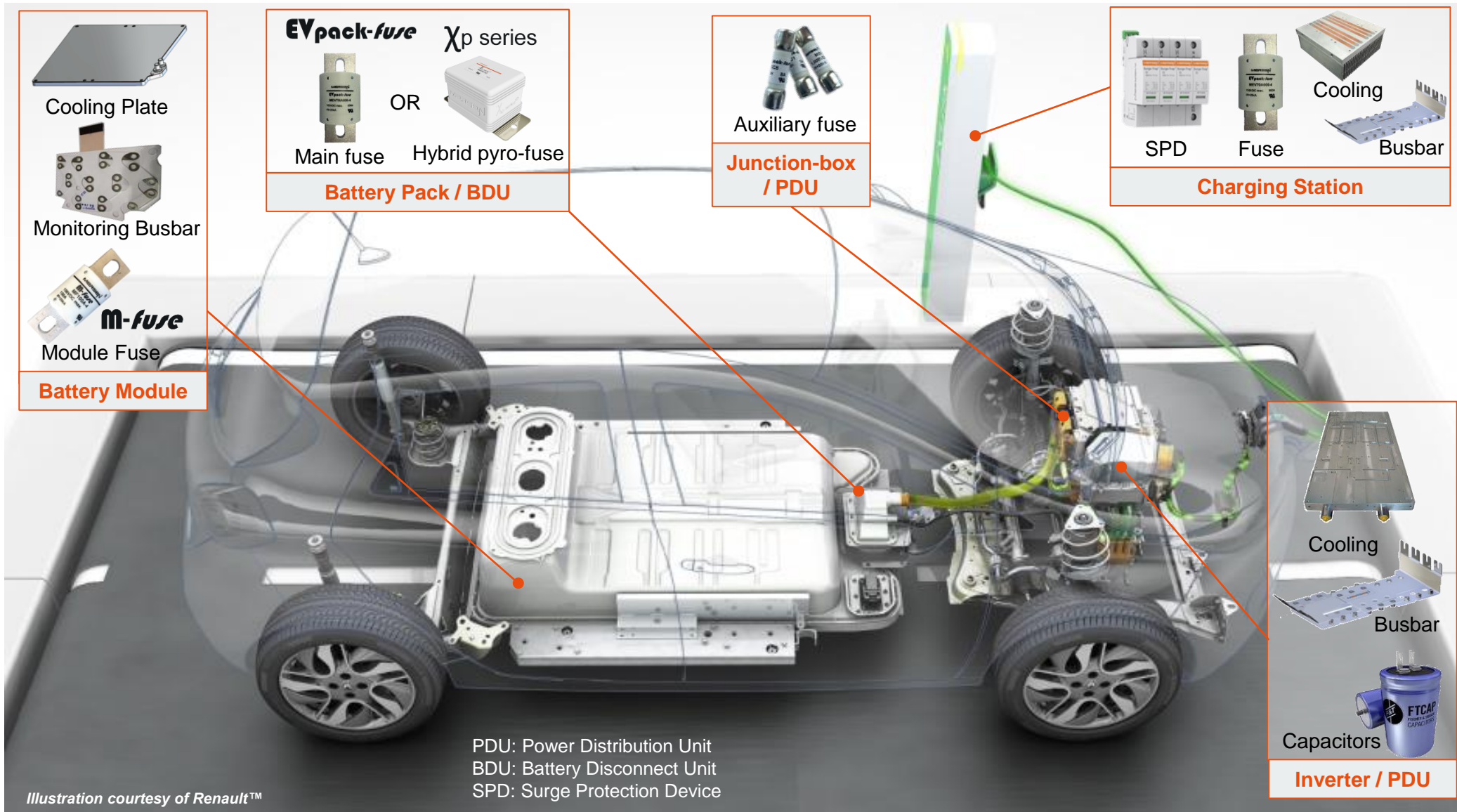


One of 16 Trophée Andros 2021, 100% electric race car, equipped with Mersen Busbar and Fuses

EV/HEV MARKET SEGMENT PERFORMANCE ADDED-VALUES

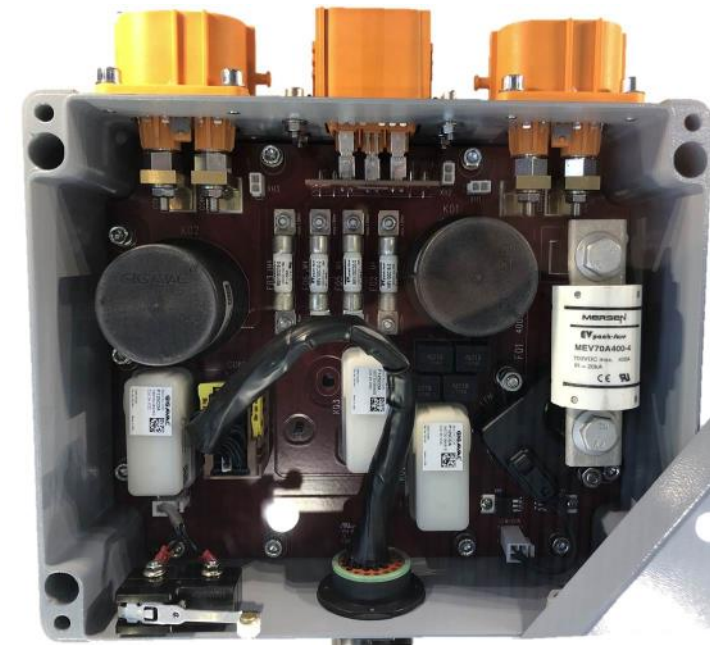


MERSEN SOLUTIONS IN EV/HEV APPLICATIONS





DC BATTERY OVER CURRENT PROTECTION

MAIN AND AUXILIARY FUSE AND
PYRO-FUSE



DC PROTECTION FOR EV BATTERY

2 TECHNOLOGY PATHS

	Monolithic technology	Hybrid pyrofuse technology
Product range	EV pack-fuse M-fuse	Xp series
Core technology	DC-Fuse	Pyro actuator + Fuse
Value-proposition	<p>Ultra fast-acting fuses (for large fault currents)</p> <p>Cost-effective & proven technology</p> <p>DC specific design</p>	<p>Fast-acting protection < 1ms</p> <p>Low-cost technology</p> <p>Close-to-zero conduction loss</p> <p>Operates for small or large fault current</p> <p>Fully configurable. Self-triggering option</p> <p>Very compact size</p> <p>High cycling performances</p> <p>High inrush current capabilities</p>
Visuals		

EV TYPICAL PROTECTION SCHEME

Main battery pack
1 to 16 battery modules assembled in series/parallel



Main protection
(main fuse + DC contactor)



500 to 1,000 Vdc
Up to 600 A

1x (or 2x)



EVpack-fuse®

or



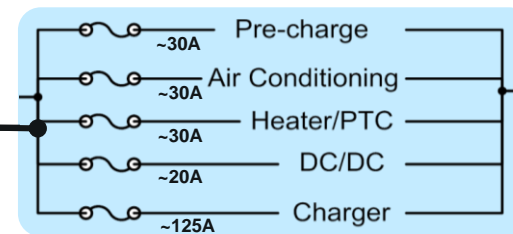
Xp series®

(500V or 1000Vdc)



Inverter + Motor

Aux. protection



500 → 1,000 V

4x to 8x



10 → 50 A for aux.

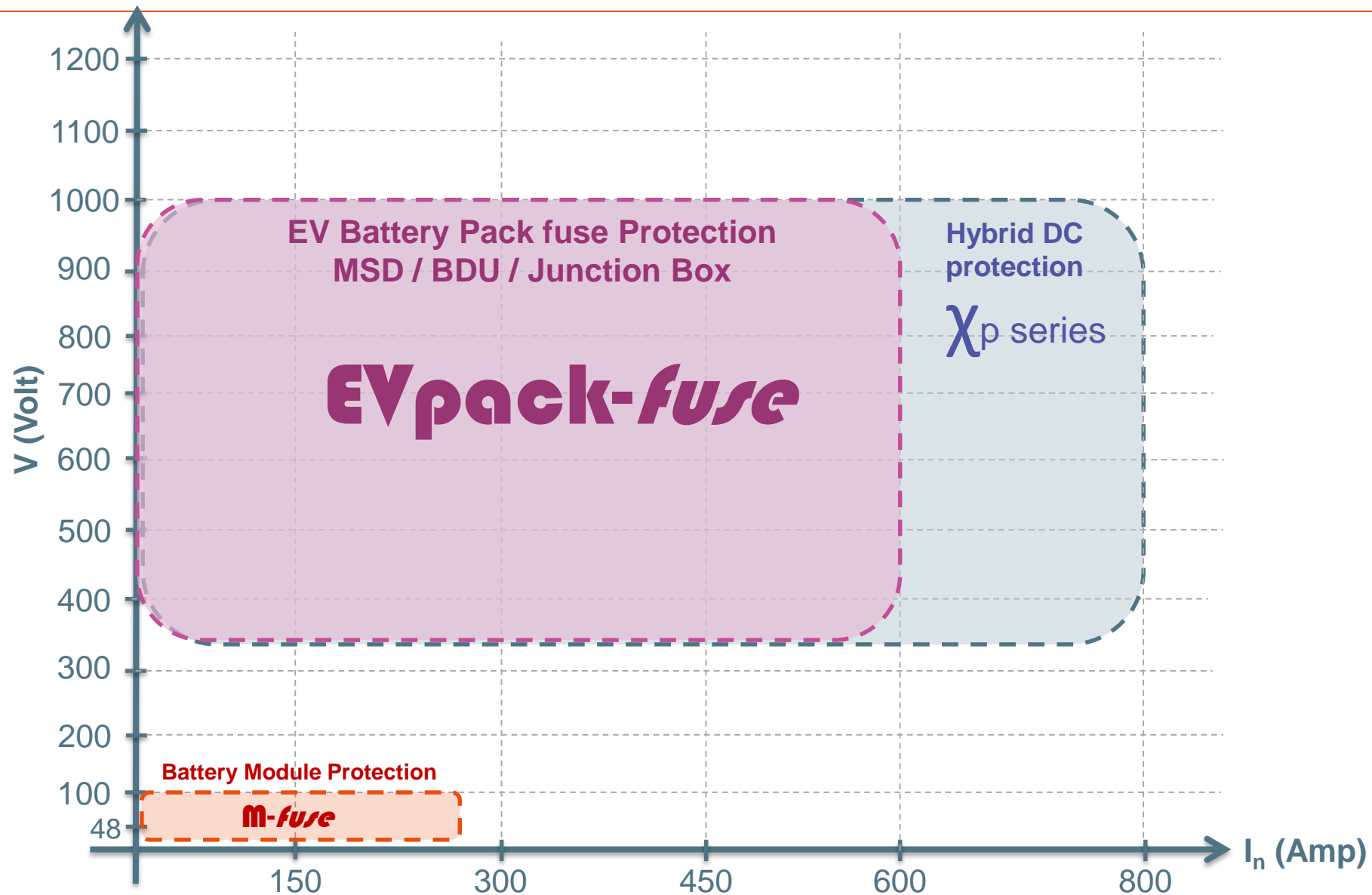
+ 1x



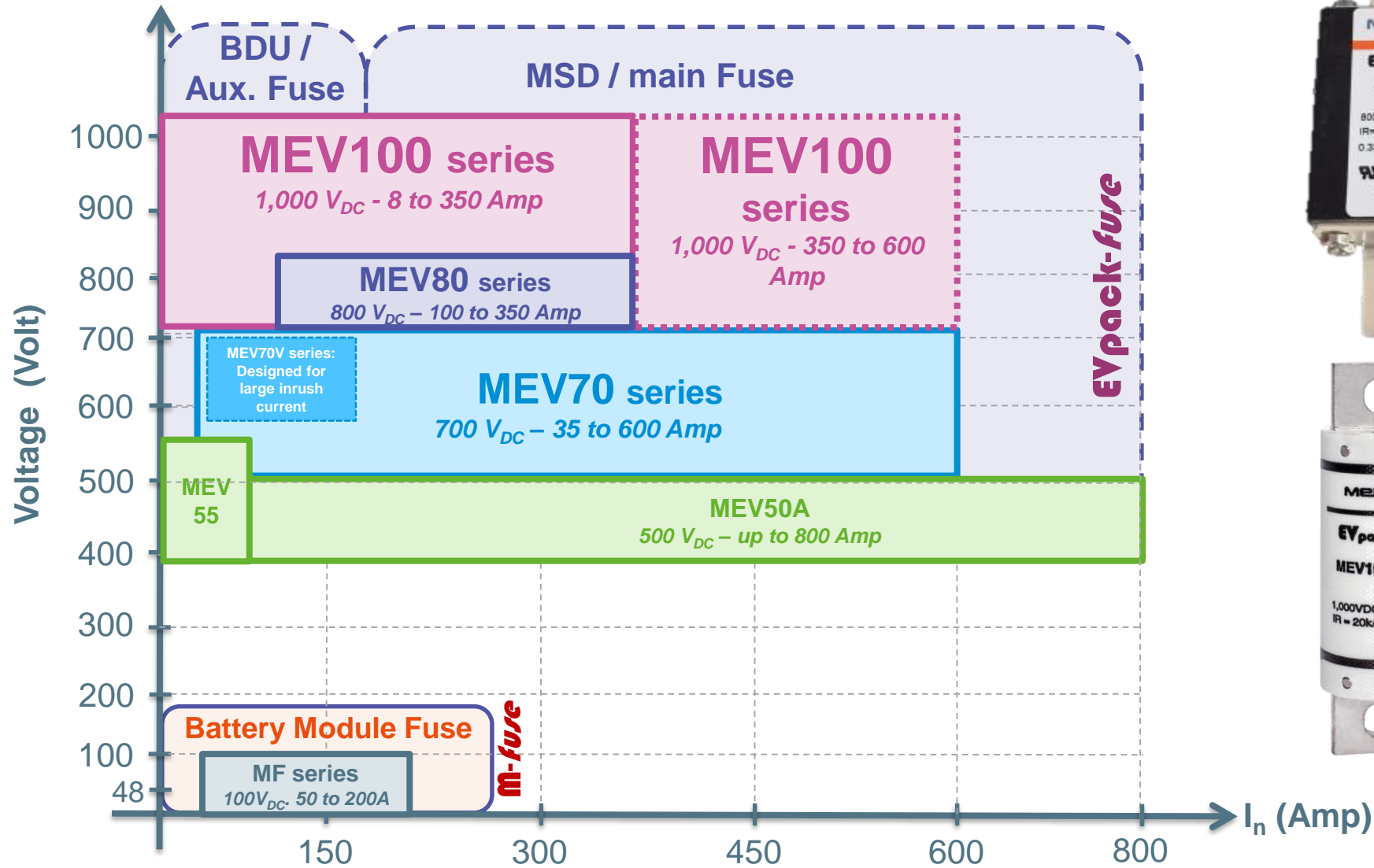
Up to 150A for charger⁽²⁾

EVpack-fuse®

2 FAMILIES OF PROTECTION AND OPERATION DEVICES FOR DC APPLICATIONS



8 DC FUSE SERIES FOR BATTERY PROTECTION



PRODUCT HIGHLIGHT: MEV50A SERIES – 500VDC EV FUSE



PERFORMANCE

- Low Minimum Breaking Capacity (4xIn or 2kA) to secure contactor protection
- High interrupting rating of 30kA to address all types of battery
- Highly energy efficiency with low power losses
- Excellent cycling capability
- Compliant with ISO 8820 and international electrical standards



FEATURES & BENEFITS

- Voltage: 500VDC - L/R \leq 2.5ms
- Ratings from 60 to 800A
- 5 compact sizes
- Long life cycle
- Visual identification code & serial number for traceability
- Customizable design
- Tested and validated with market leading contactors (Panasonic, Hongfa, TE, etc.)



MERSEN **EV_{pack-fuse}** HAVE BEEN DESIGNED TO MATCH DC CONTACTOR OPERATION. *MBC VALUE MATTERS...*

- **MATCHING DC CONTACTOR WITH DC FUSE IS NOT TRIVIAL. CONTACTORS OFFER A LIMITED MAX. BREAKING CAPACITY VALUE BEYOND WHICH THE FUSE MUST CLEAR THE CIRCUIT IN THE EVENTUALITY OF A DEFAULT . TYPICAL MATCHING SCHEME LOOKS LIKE:**

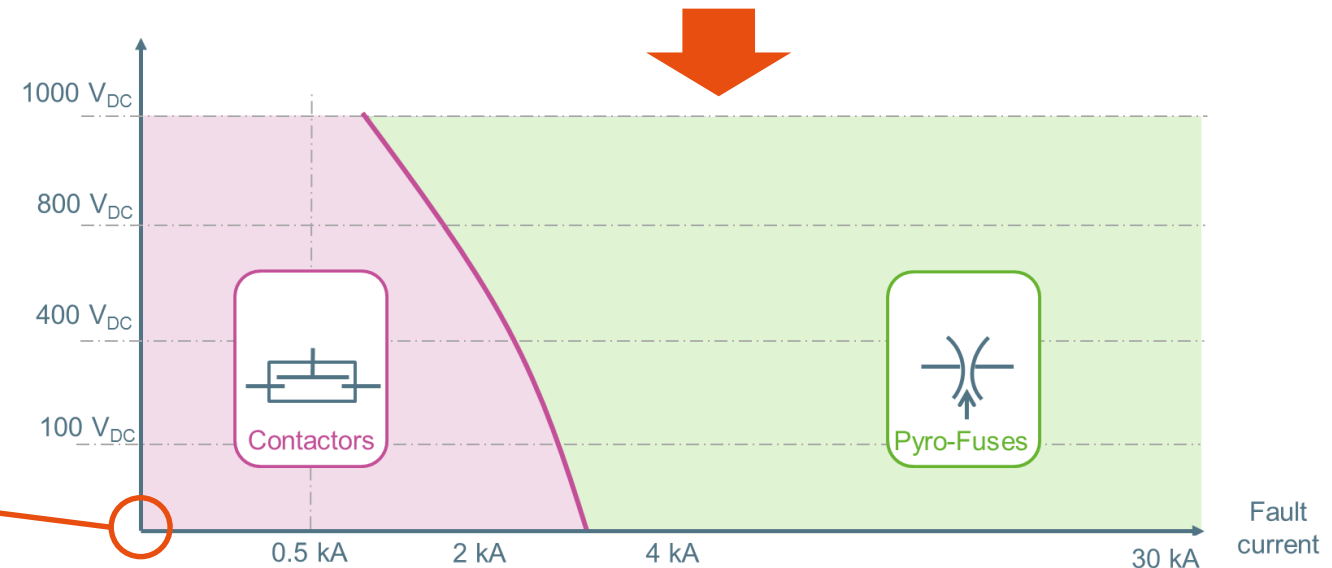
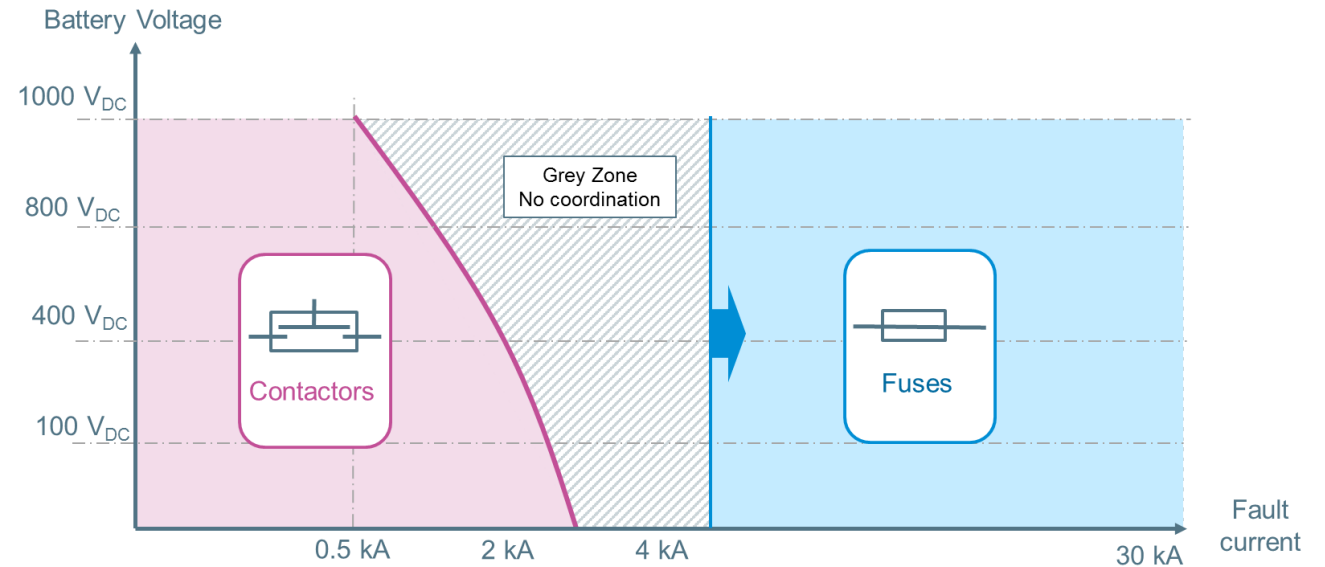


- **EV_{PACK-FUSE} LINE-UP HAS BEEN DESIGNED TO PROTECT DC CONTACTORS, OFFERING MBC VALUES <3kA OVER THE FULL RANGE.**

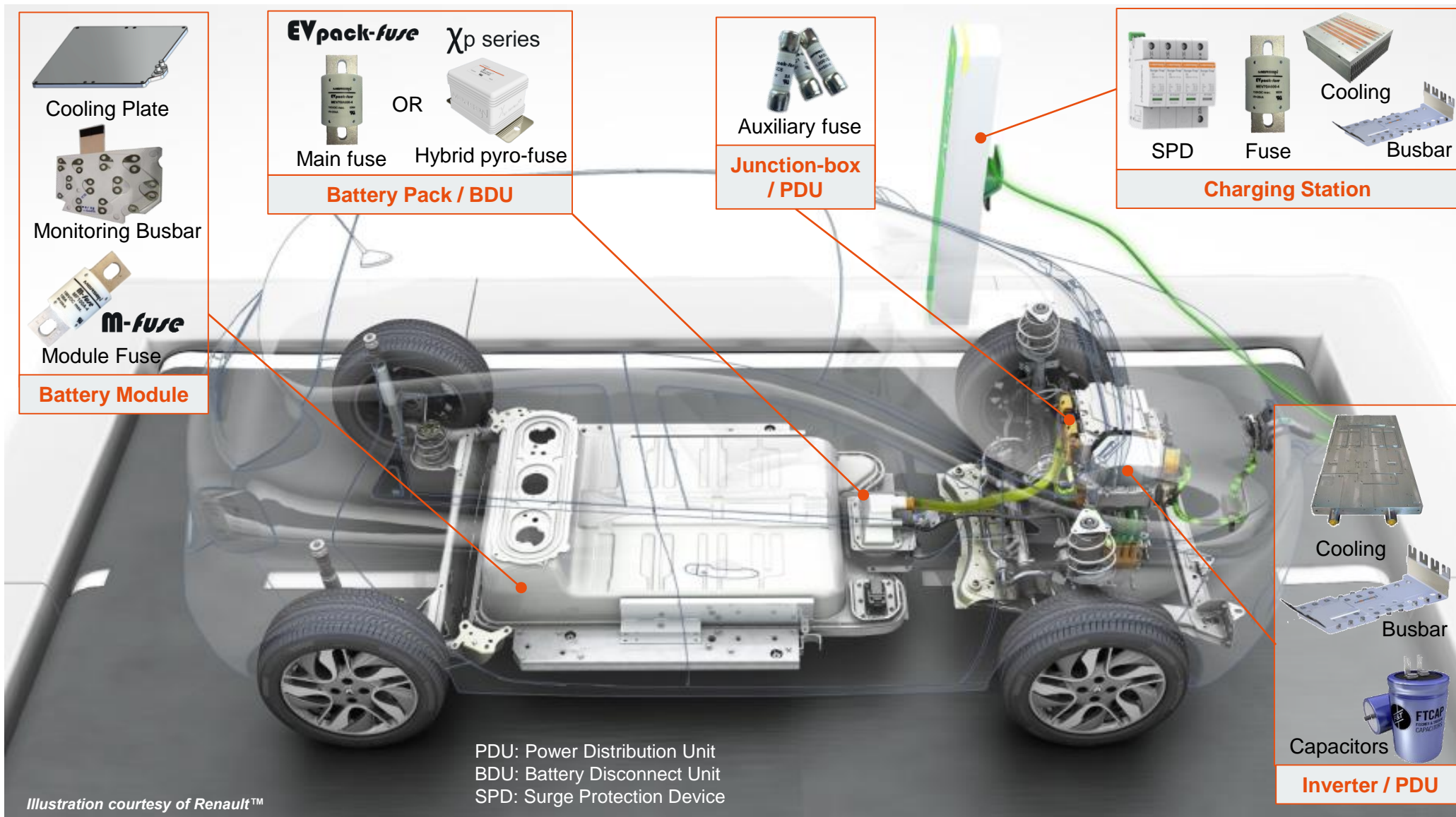
HYBRID PYRO-FUSE (XP-SERIES) FUNDAMENTALS

HOW PYROFUSE ALLOWS BETTER COORDINATION WITH CONTACTOR WHATEVER THE VOLTAGE & CURRENT

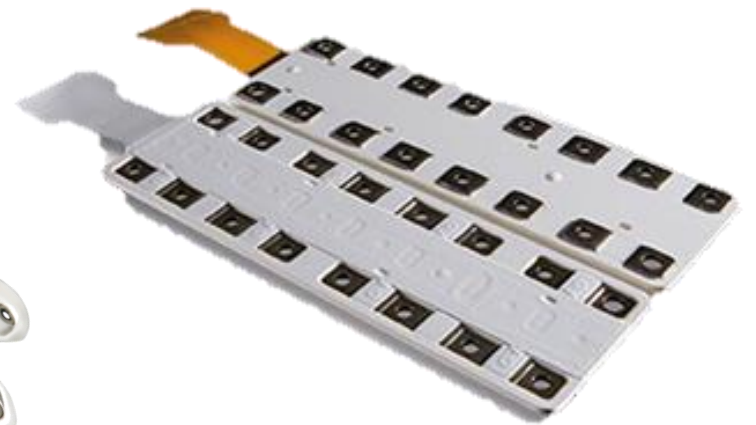
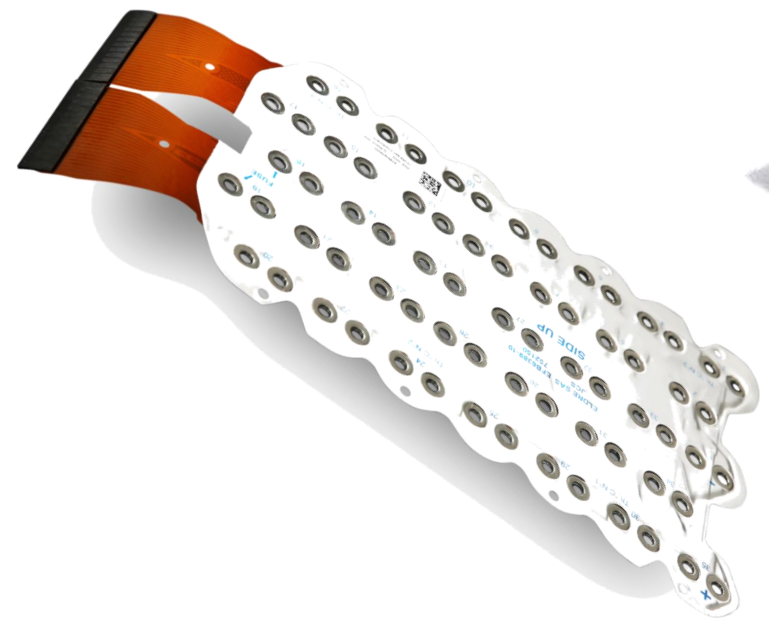
- WITHIN EV BATTERY PROTECTION SCHEME, FUSE AND CONTACTOR SHOULD COORDINATE TOGETHER WHATEVER CURRENT AND VOLTAGE CONDITIONS.
- IN REALITY IT'S NOT !
A "GREY ZONE" REMAINS WHERE NONE OF THEM CAN SAFELY OPERATE
- PYROFUSE ALLOWS EXTENDING THE "FUSING" OPERATION TOWARDS SMALLER CURRENT AND ENABLES FULL COORDINATION
- PYROFUSE IS NOW ALSO REQUESTED TO OPERATE EVEN IF NO CURRENT (0-AMP)



MERSEN SOLUTIONS IN EV/HEV APPLICATIONS

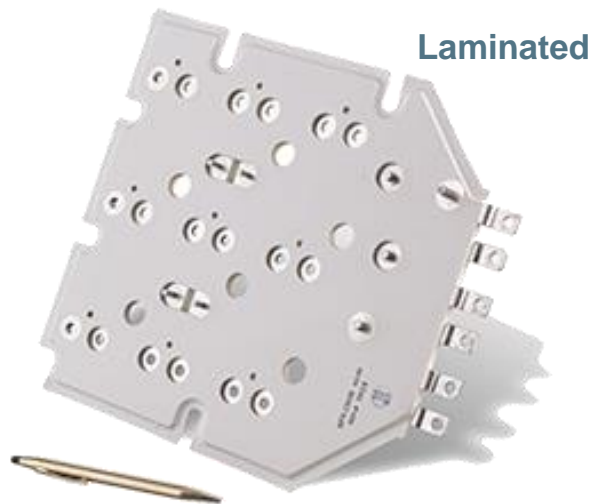


LAMINATED & MONITORING BUSBAR



ENGINEERING AND MANUFACTURING EXPERTISE

- LEVERAGING OVER 65 YEARS OF EXPERIENCE IN DESIGNING, MANUFACTURING AND TESTING BUS BAR SOLUTIONS
- GLOBAL ENGINEERING & R&D TEAMS
- EXTENSIVE IN HOUSE MANUFACTURING CAPABILITIES AND VENDOR NETWORK
- WIDE ARRAY OF BUS BAR TYPES AND VALUE ADD ASSEMBLIES
- SERVING CUSTOMERS WITH HIGH COMPLEXITY BUSINESS



MERSEN SUPPLIES 3 DIFFERENT TYPES OF BUSBAR IN THE EV INDUSTRY

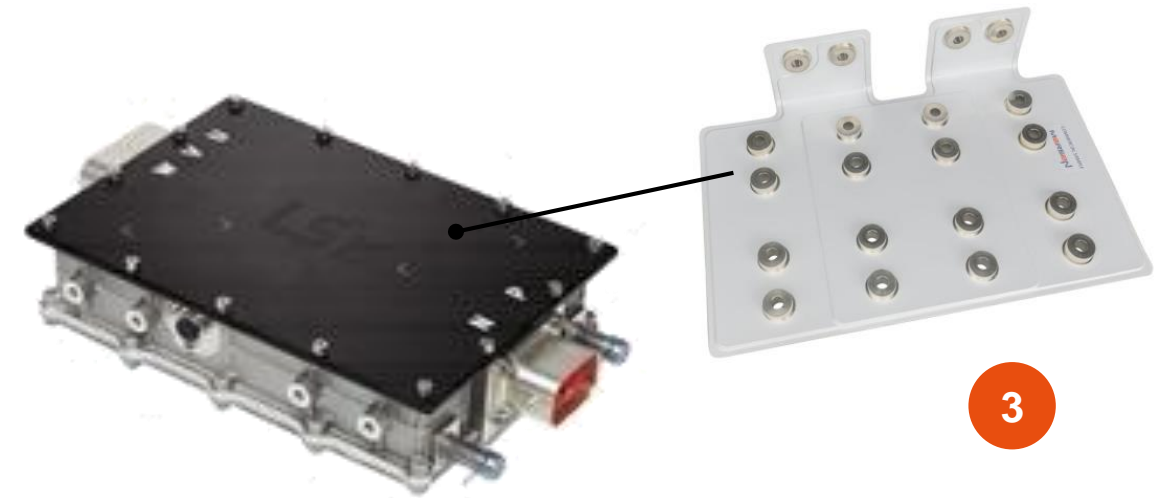
Battery busbar

To connect cylindrical, pouch or prismatic cells



Inverter busbar

To connect power electronics components



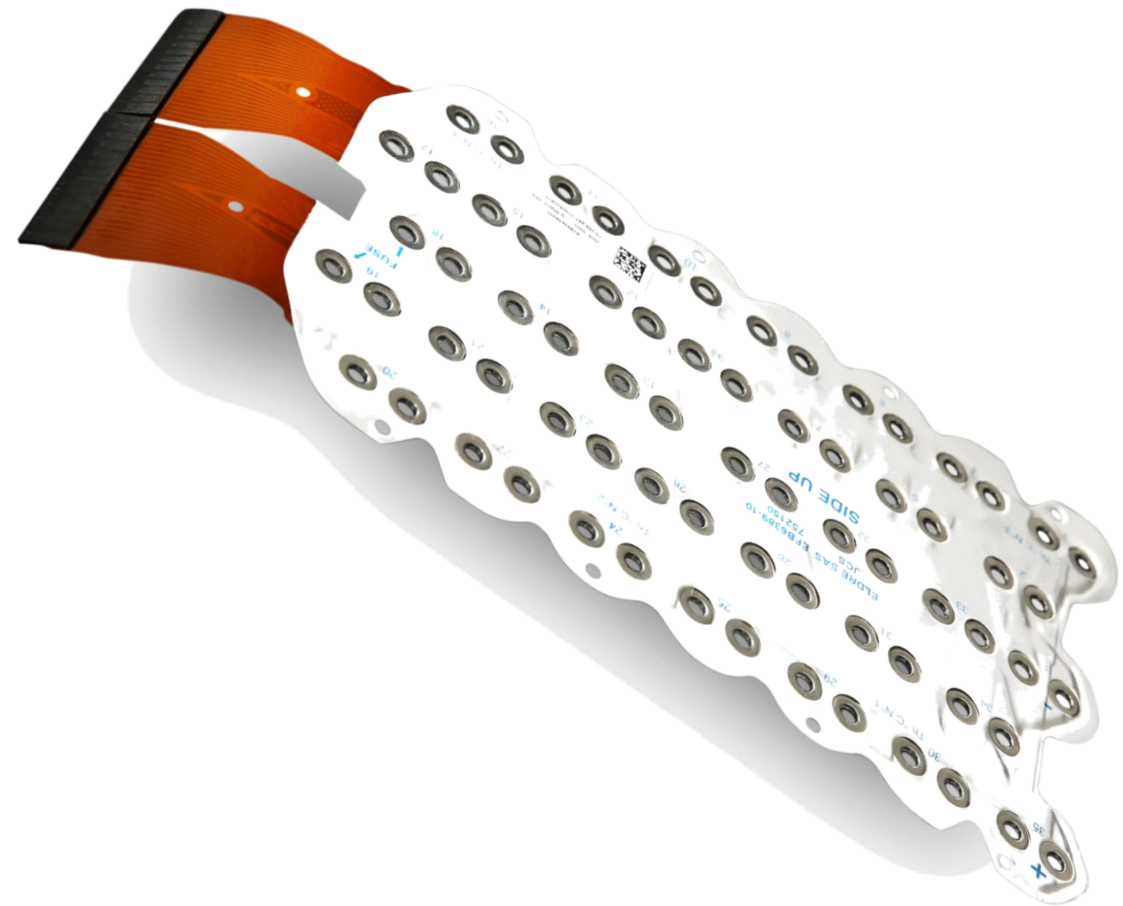
SMART MONITORING BUSBAR TO HANDLE BOTH HIGH POWER AND SMALL SIGNAL IN A SINGLE CONNECTION SOLUTION

■ ALL-IN-ONE CONNECTION SOLUTION:

- Connect Li-ion or supercap cells together
- Monitor small signals such as
 - Individual cell voltage
 - Local temperature

■ CUSTOMER'S BENEFITS:

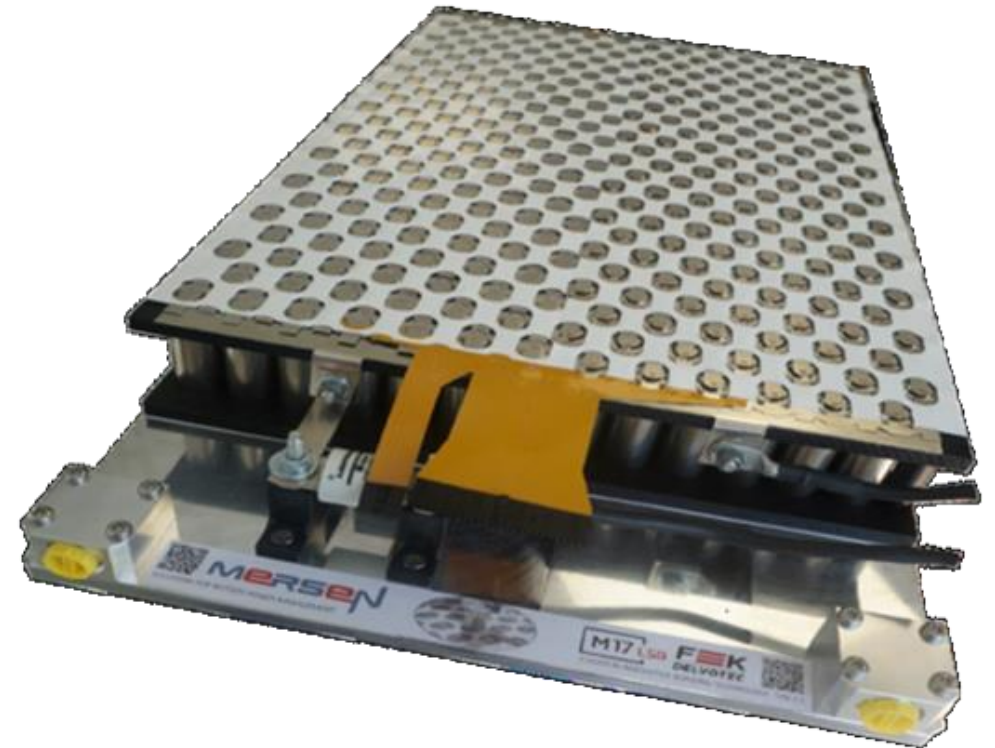
- Ease assembly process
- No wiring errors
- Reduced voltage drop
- Increase current carrying capability
- High resistance to shocks and vibrations





INFINI[∞]CELL: LOW-COST AUTOMATED LAMINATION PROCESS FOR MODULAR BATTERY CELL CONNECTION

INFINI[∞]CELL
Always moving ahead.



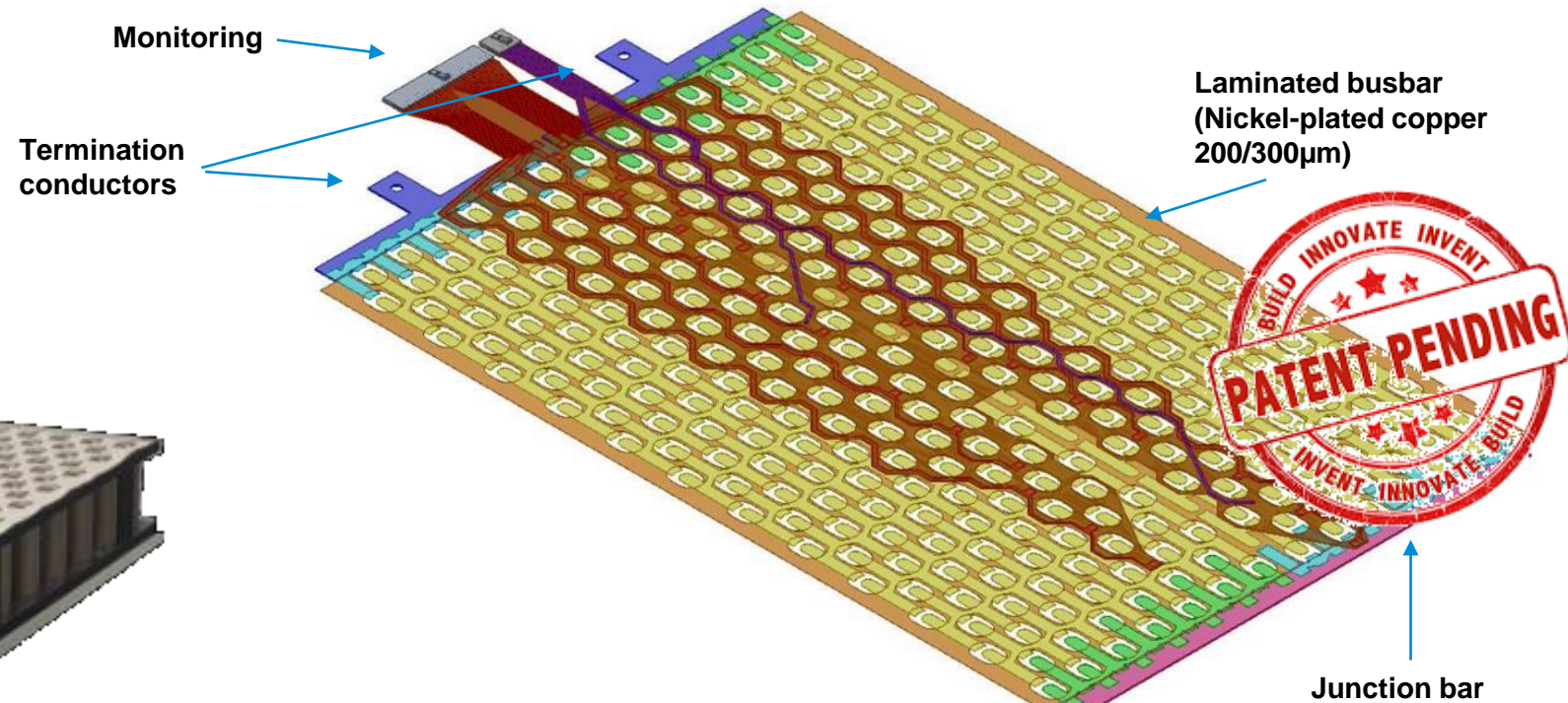
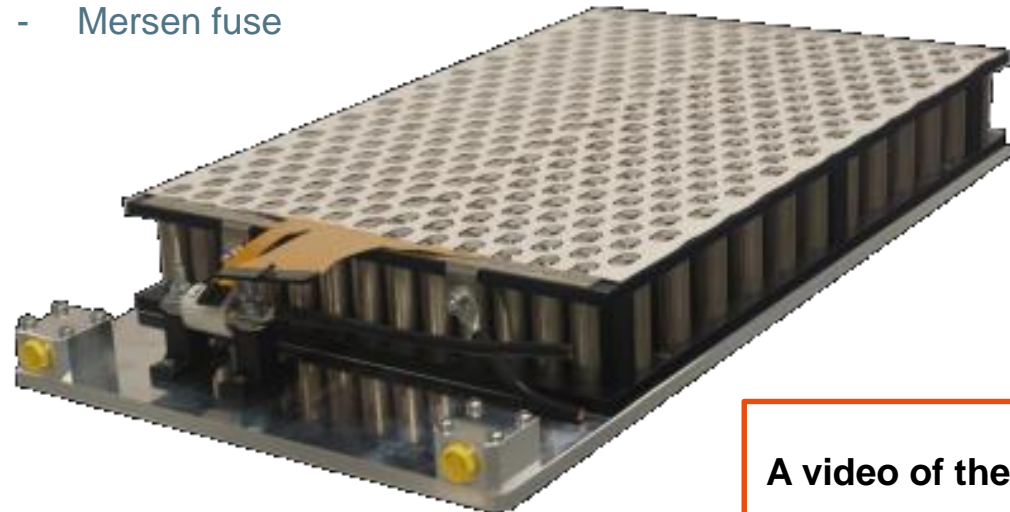
INFINI[∞]CELL: A NEW CONCEPT FOR BATTERY CELL CONNECTION

INFINI[∞]CELL
Always moving ahead.

In the frame of a collaboration with laser-welding equipment manufacturer F&K Delvotec (GE) we have developed a prototype of battery pack, connecting cells (21700 type), with a **single-layer interleaved busbar**, and using a **automated high-speed lamination** process:

A demonstrator is now available for showcasing, including:

- A laminated busbar (with monitoring)
- Cooling plate
- Mersen fuse



A video of the process assembly is available here:  **YouTube**

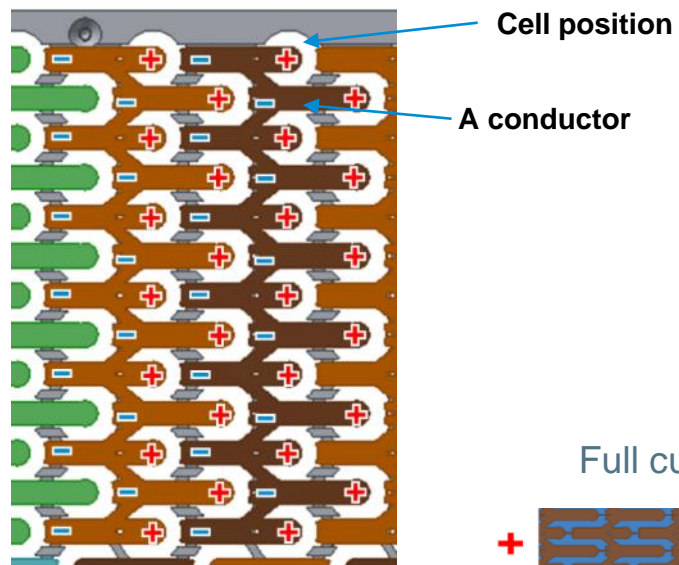
F&K
DELVOTEC

For laser welding

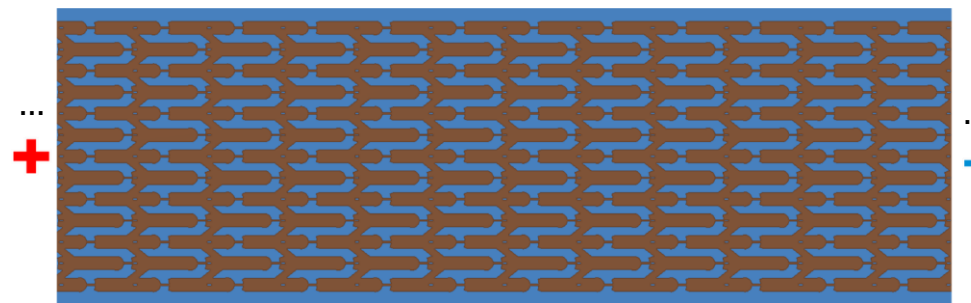
MERSEN

INFINI[∞]CELL CONCEPT: A FULLY FLEXIBLE PROCESS

A single-layer interleaved busbar, allowing + and – welded on the same side:



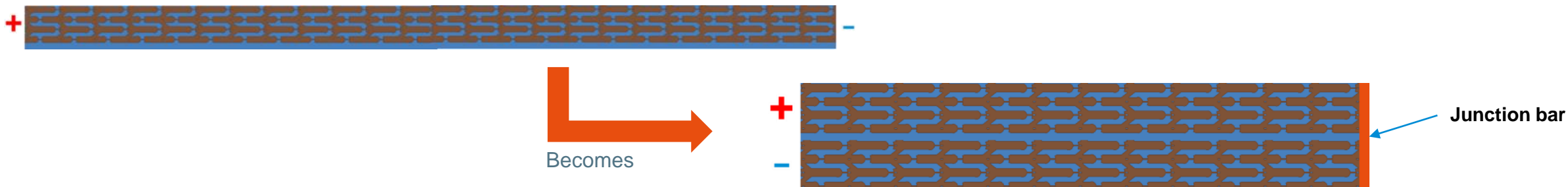
Raw material : A duplication of the same pattern, forming a foil of, virtually, infinite length:



Full customization and adaptation by adjusting the foil in width and/or in length :



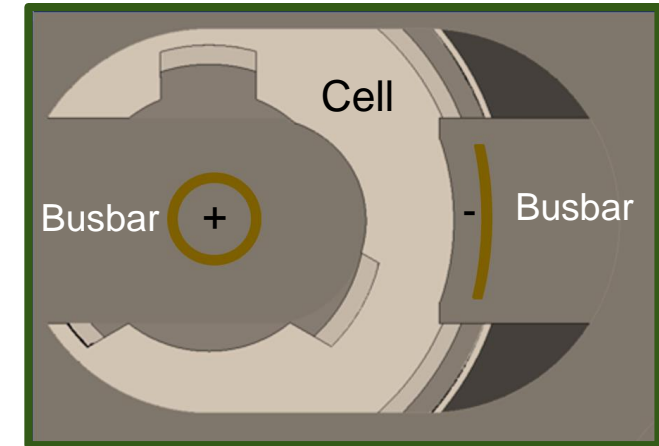
On request, foil can be split in 2 or more parts to reduce the final length. In this case, junction bar is used to connect foils together:



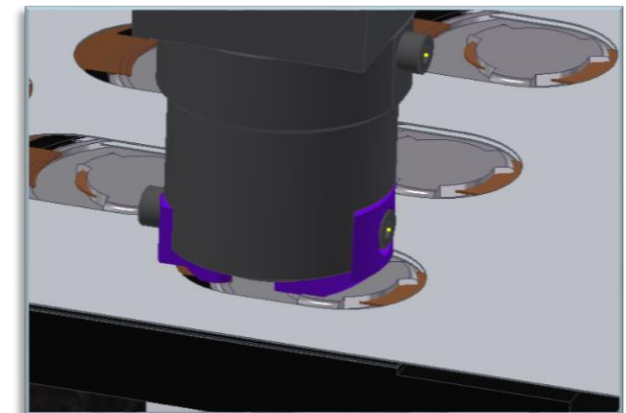
INFINI[∞]CELL: FOCUS ON LASER WELDING PROCESS

INFINI[∞]CELL
Always moving ahead.

- **LASER WELDING PROCESS HAS BEEN DEVELOPED IN PARTNERSHIP WITH F&K DELVOTEC, A GERMAN EXPERT IN LASER WELDING EQUIPMENT AND PROCESS**
- **LASER WELDING IS >4X FASTER THAN WIRE BONDING**
 - 2 in 1 TAB welding (+ and – poles are soldered in one pass) is inherently >4x faster than conventional wire/ribbon insertion & cutting.
- **IT USES A POWERFUL 1kW CW 1070NM LASER IN ADDITION TO A BOND FORCE UP TO 60N APPLIED AT THE SAME TIME BY THE TOOL.**
- **ZERO GAP CERTAIN**
 - The tool touches every weld in +/-1µm

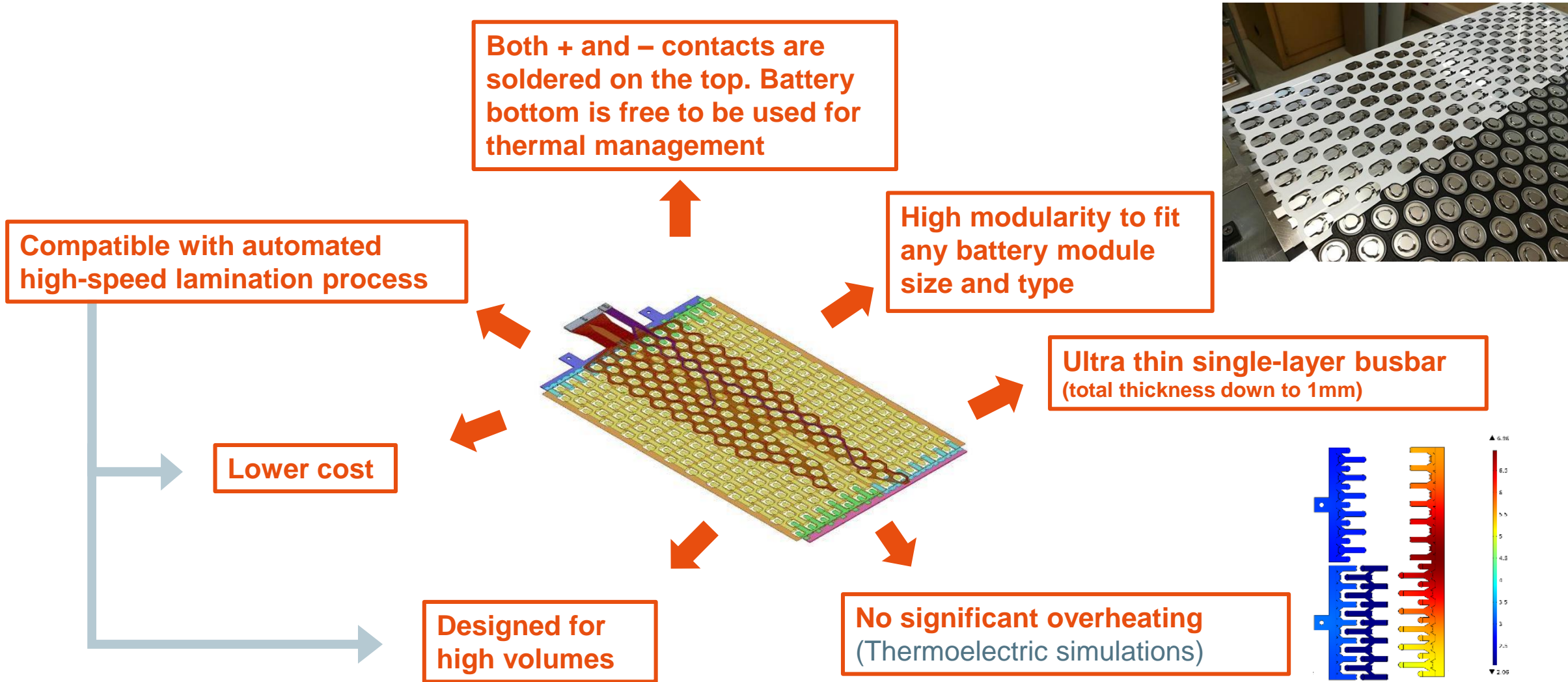


+ and – contacts are simultaneously soldered on the top of the battery cell. One on the center, one on the gasket)

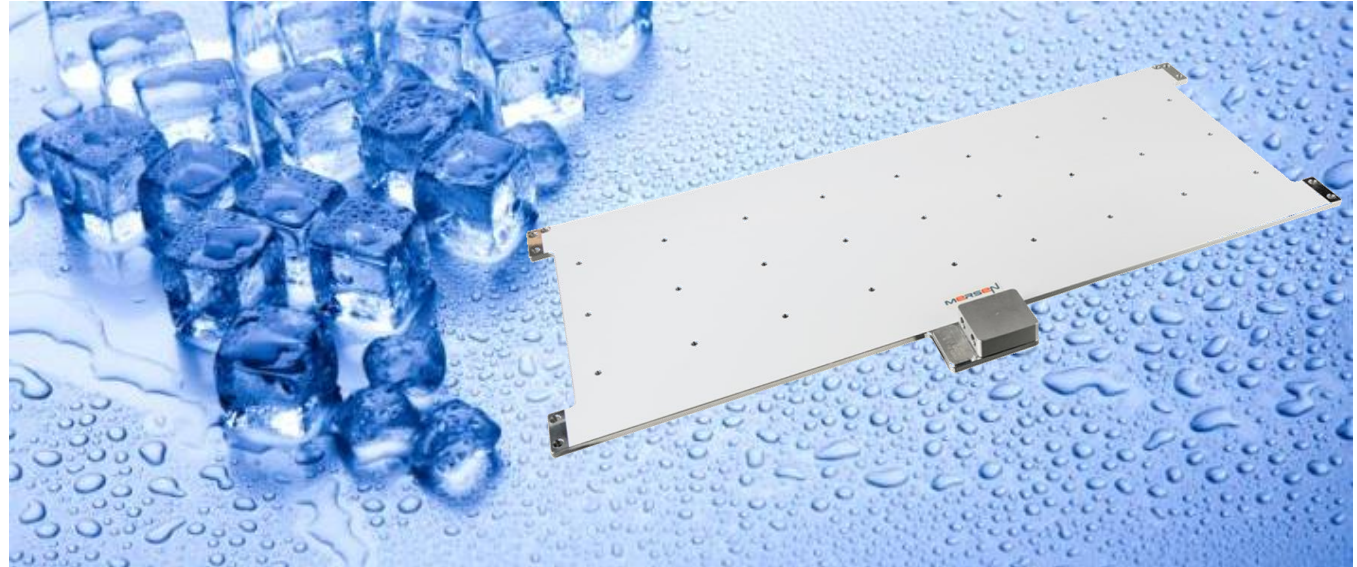


Detail of the tool specifically developed by Delvotec to fit Mersen busbar design

INFINI[∞]CELL : VALUE PROPOSITION

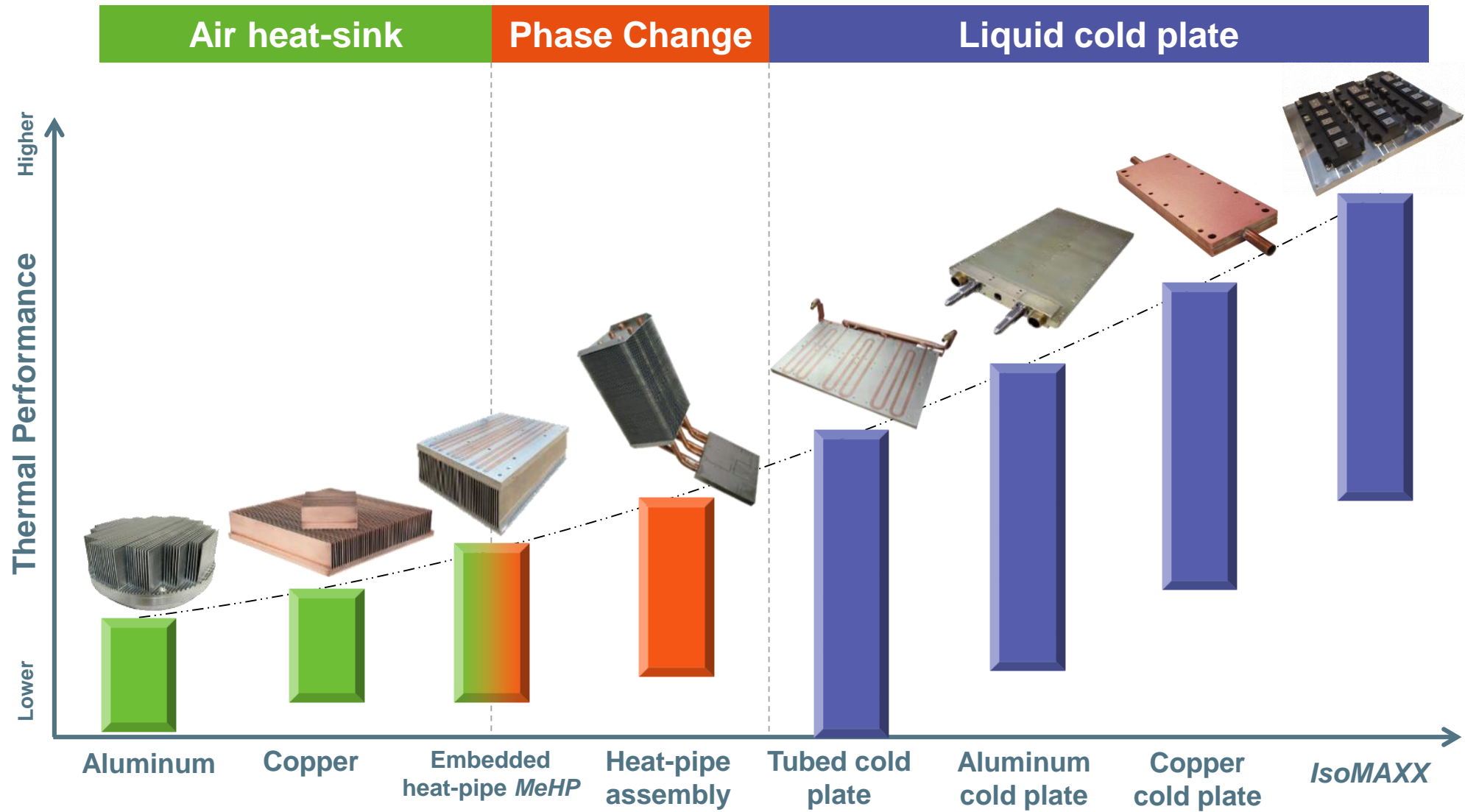


COOLING SOLUTIONS



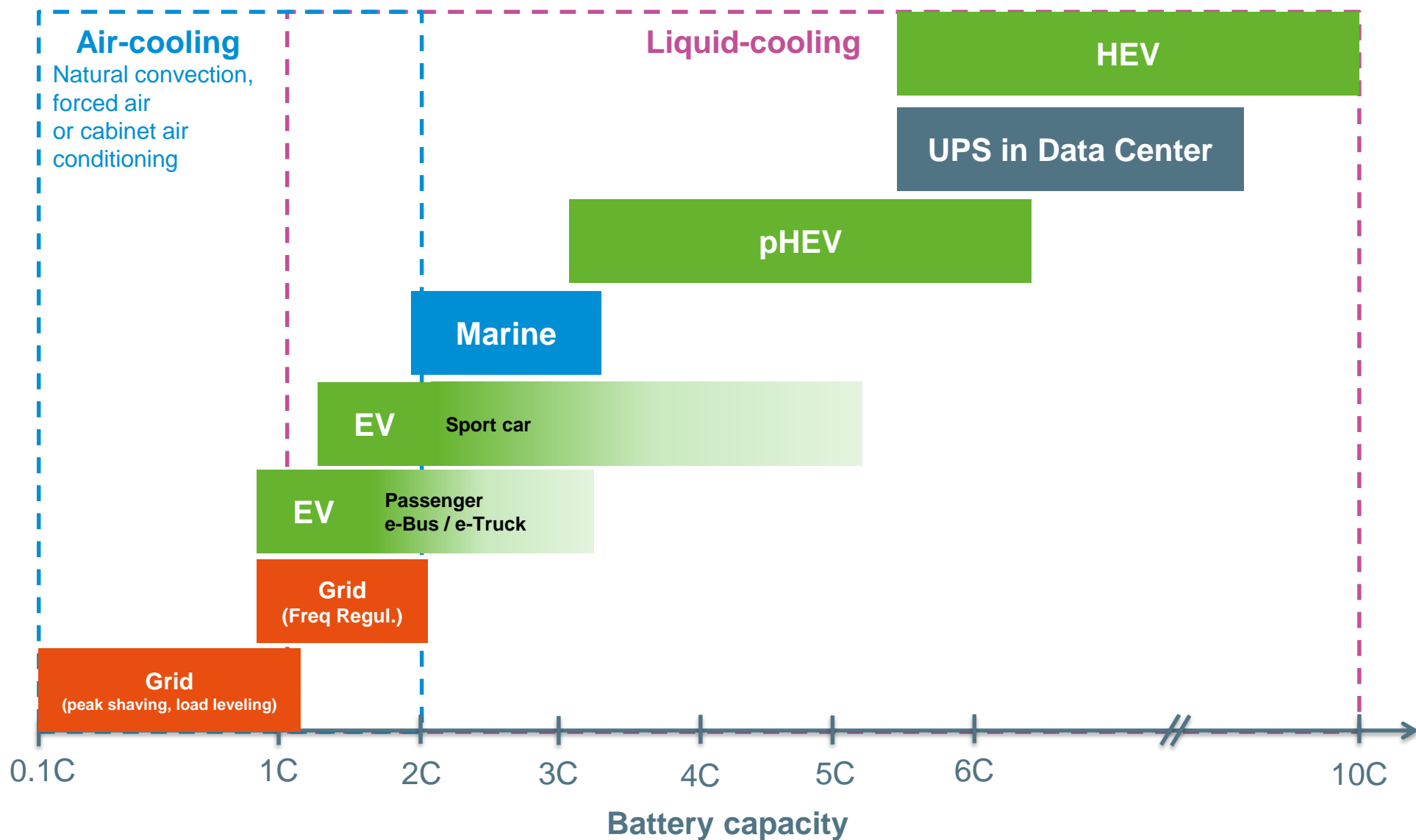
THREE COOLING TECHNOLOGIES

TO MEET CUSTOMER'S NEED AT THE CLOSEST



BATTERY USAGE SEGMENTATION

COOLING TYPE DEPENDS ON C-RATE VALUE



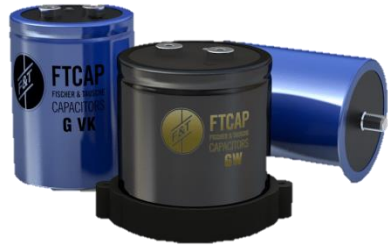
EXAMPLE OF 7MM-THICK AL VACUUM-BRAZED LIQUID COLD-PLATE FOR BATTERY COOLING (HERE WITH OPTIONAL DIELECTRIC LAYER)



SPECIALTY CAPACITORS



ALUMINUM ELECTROLYTIC CAPACITORS



Screw Terminals



Snap-In



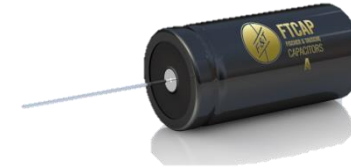
Solder Lug



Motor Start



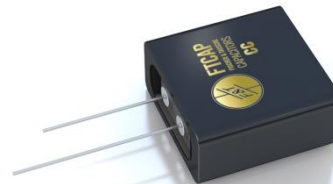
Special Type



Axial



Cuboid Axial



Cuboid Radial



Discharge Capacitors

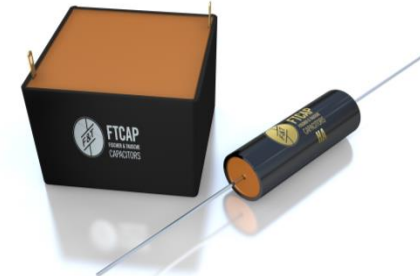
METALIZED FILM CAPACITORS



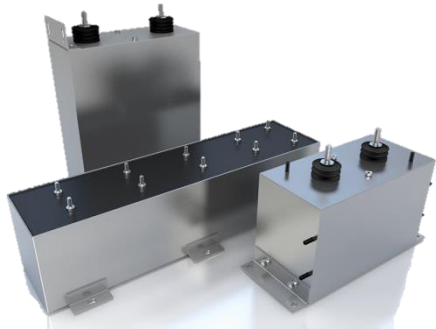
Coax Cap



Energy Cap



High Voltage



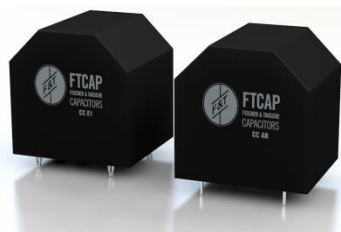
Power Box



Special Types



Joule Cap



Castor Cap



Power Link

CUSTOMIZED SOLUTIONS – VALUE-ADD ASSEMBLY

