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Making the Move from 400V to 800V EVs, What Are the Test Challenges?

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What Are the Test Challenges?

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The Rise in EV Adoption

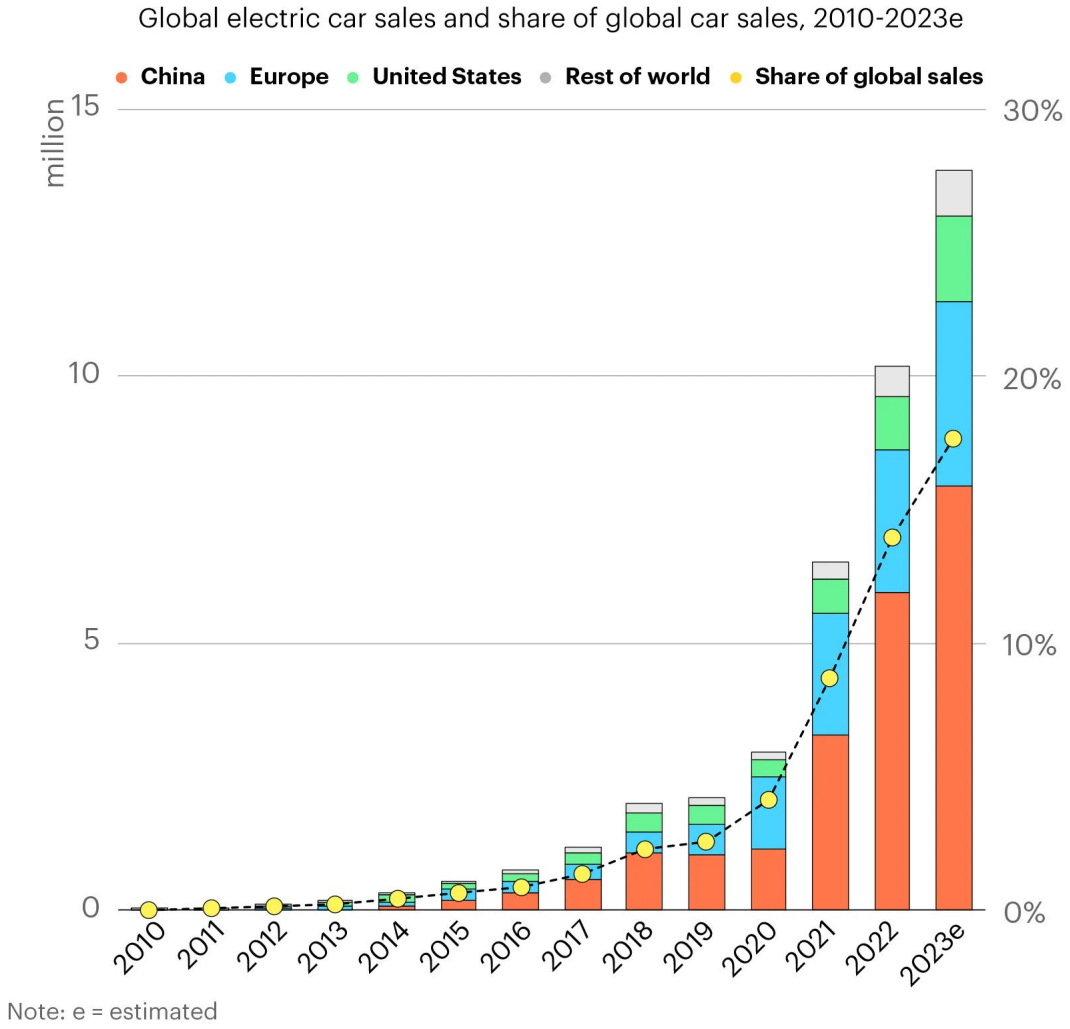
2023

- 13.8 million EVs were sold

2024

- Likely to increase to 17.8 million
- 25% of the overall car sales

Electric cars are booming – global sales are on course to jump 35% this year to 14 million



Note: e = estimated

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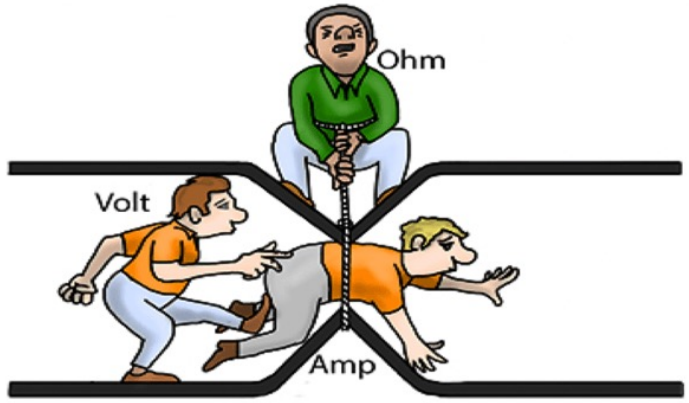
Current Challenges with EV (400V)

- **Long charging times**
- **Energy losses impacting driving range**
  - **Efficiency:** Thicker cables, increase in weight
  - **Thermal management:** Complex cooling solutions to manage heat due to fast charging.



The Solution some of the EV manufacturers have proposed is to go to 800V Architecture

- It's an **evolution** rather than a revolution!

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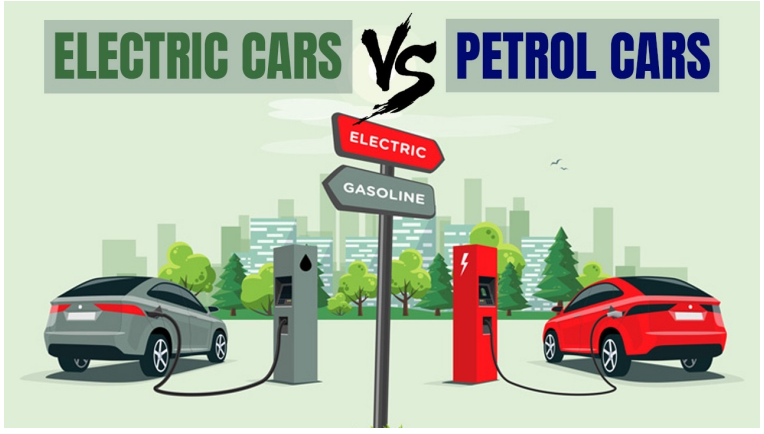
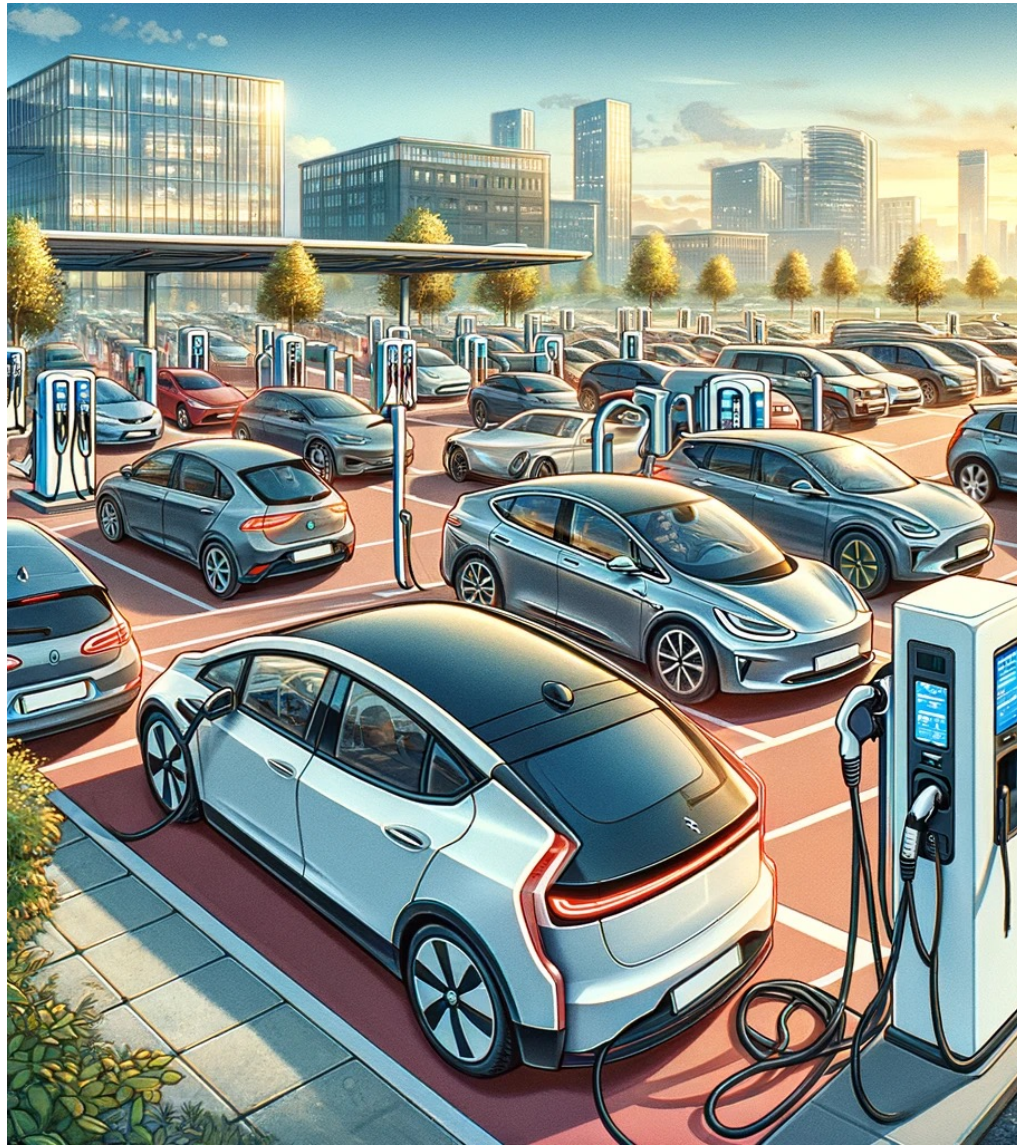
Advantages of 800V

Significant Improvement in Charging Time

- Theoretically, double the voltage means the charging time could be halved.
- Charge 10-80%: **15-18** min vs up to 30 mins using standard 400V architecture.
- Fewer queues at charging stations.

However, the current EV architecture is around 400V so there will be significant challenges in making the charging infrastructure around 800V.





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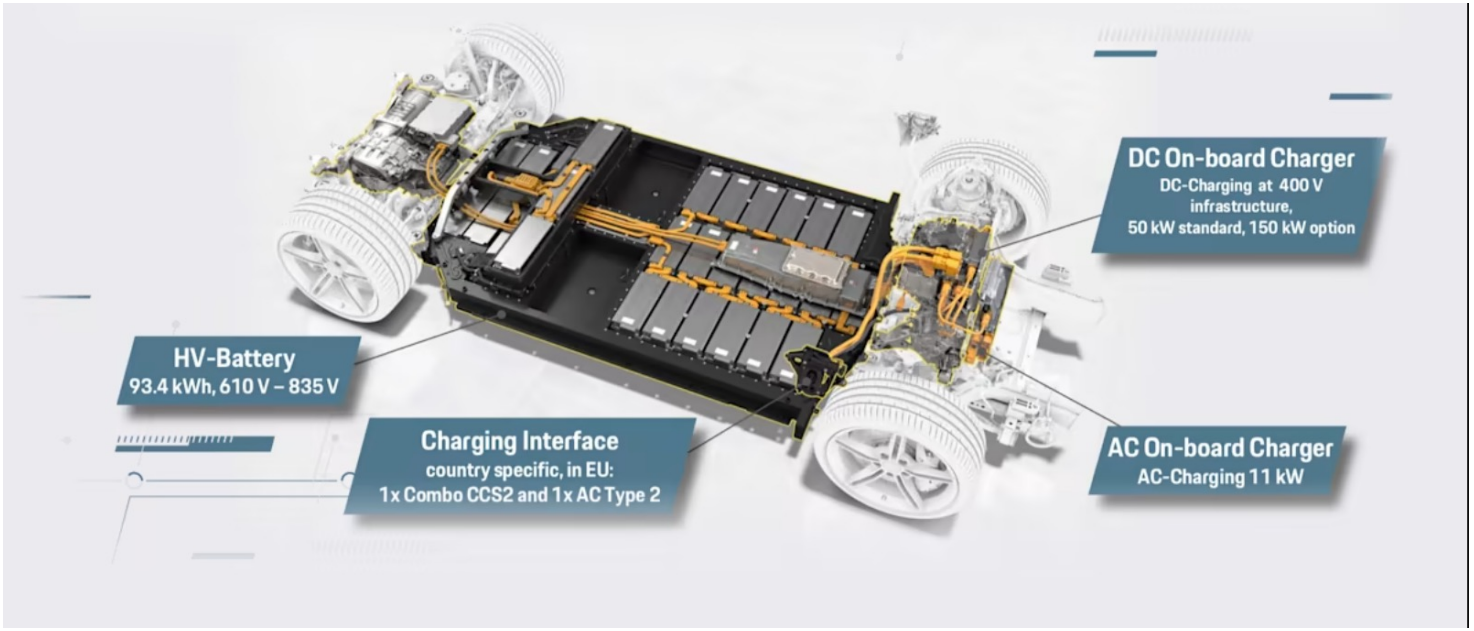
Advantages of 800V

Improved Range and Efficiency

- **Efficient Power Management**: Leading to improvements in the vehicle's range as less energy is lost during the conversion processes.
- **Lighter Wiring**: Higher voltage means the current needed for the same power output is lower, allowing for thinner wires, and reducing overall vehicle weight, which can also contribute to better efficiency and range.



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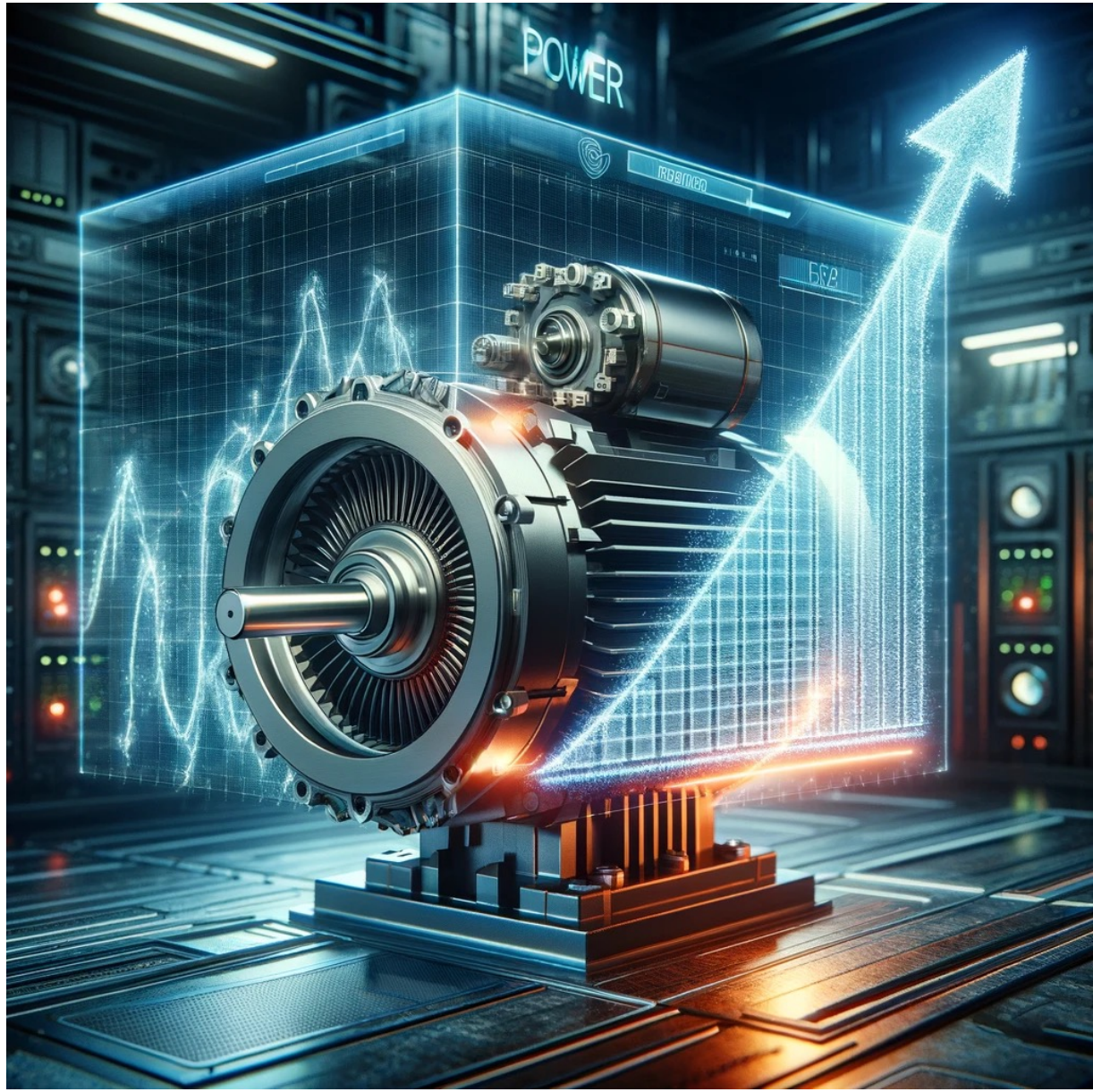
Advantages of 800V

Enhanced Performance

- **Power Delivery:** 800V systems enhance high-performance EVs with quicker acceleration and better handling.

- **Thermal Management**: Improved thermal management with high voltage maintains battery health and extends its life.

- $P_{loss} = I^2R$



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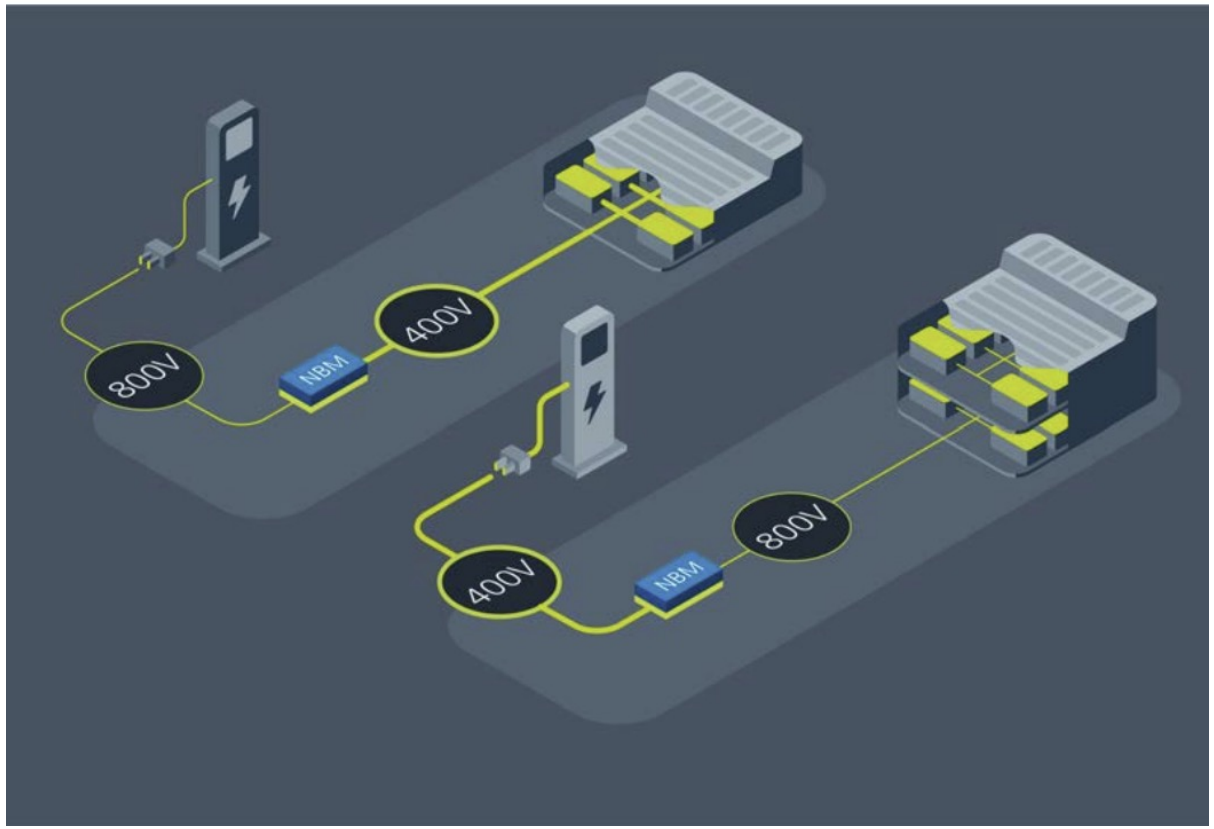
Challenges for Making the Shift to 800V

- **Charging infrastructure compatibility**
  - Additional DC-DC Converters are required to adapt to 400V charging
- **Additional BMS Complexity due to doubling the number of cells connected (in series).**
  - Robust and accurate measurements at higher voltages.
- **Rapid Discharge capability**
  - Higher energy needed to be dissipated.



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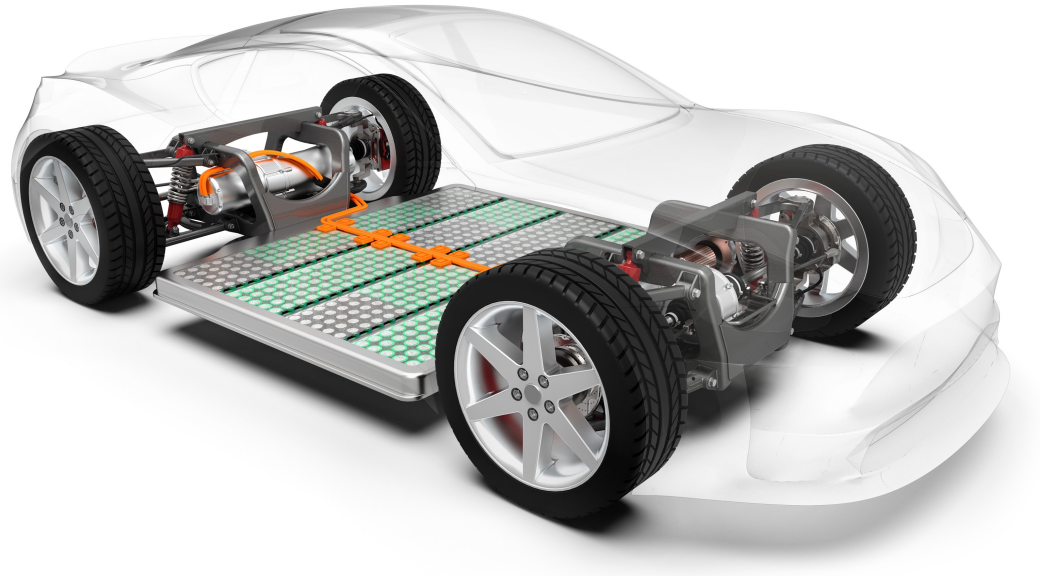
Challenges for Making the Shift to 800V

- Electromagnetic interference(EMI) at higher voltages.
- Prevention from electrical breakdown and arcing at 800V
- Electrical Isolation from ground and other electrical systems.
- Maintaining a high level of signal integrity.



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Test strategies such as **Hardware-in-the-Loop (HIL)** testing are often performed at this stage.

- HIL setups can replicate real-world conditions e.g. battery cells, temperature, pressure, vibrations etc.
- Design weaknesses and potential issues can be identified at earlier stages.
- Extreme fault conditions (for instance discharge on an 800V system) can be safely simulated.

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Using Industry-standard HIL Platforms

- Modularity, Flexibility & Scalability
- COTS: Cost-effective, high level of support, global support
- Industry Standard Platforms (PXI & LXI)
- Choice, reliability, third-party support (applications, systems), longevity, obsolescence management by vendors
- Regulatory Compliance

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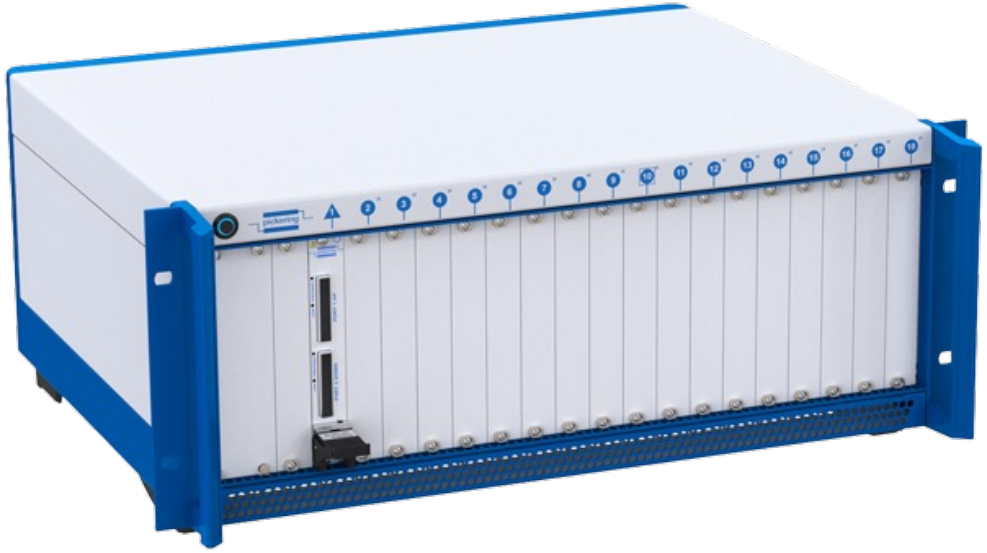
PXI Features

- **P**CI e**X**tension for **I**nstrumentation
- Rugged, modular, flexible & scalable platform for Test and Measurement
- Integrated timing/triggering for system synchronization
- Ideal for real-time operating systems due to PCI base
- System includes plug-and-play chassis, controller & modules, leading to efficient test system creation
- Mix and match multi-vendor modules and functionality from over 60 vendors, in a single Chassis



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LXI Features

- **L**AN e**X**tension for **I**nstrumentation
- No defined mechanical footprint
- Can separate physically large components from chassis
- Power and cooling requirements can be matched to application requirements
- Large test systems can be networked up to 100m over ethernet without repeaters
- Can be controlled from anywhere with network access (even across sites!)

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EV Focus

- Many modules used for developing 400V EV architecture are usable for 800V
- Where modules are not suitable for 800V and higher voltage modules exist, they can be swapped out for 800V alternatives
- Either way, migration paths exist for 800V architecture development

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Popular PXI Modules

- Battery Cell Simulation
- RTD & Thermocouple Simulation
- Fault Insertion
- High Voltage Switching

1kV Isolation Requirements

- Channel-to-channel
- Channel-to-ground

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Battery Cell Simulation

- Simulate Battery Packs to the individual cell level
- Cells can be cascaded to achieve full stack simulation or smaller sub-stacks
- Can adjust individual cells to simulate charge, charging, discharging and unbalanced stacks
- Can add additional cells to increase the stack voltage as systems transition from 400V to 800V
- Ideal for BMS Test applications

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RTD Simulation

- Resistance temperature detector (RTD)
- Temperature is relative to resistance for a given sensor type
- Simulate the behavior of Positive (PTC) or Negative (NTC) Temperature Coefficient thermistors
    - For example PT100, with nominal resistance of 100Ω at 0°C
- Many options available with channel count, range, resolution and accuracy to suite any application
- Ideal for any measurement requirements around an EV

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Thermocouple Simulation

- Utilizes two dissimilar materials to induce a potential difference in two wires of differing materials
- Temperature is relative to this potential difference
- Simulate the behavior of various Thermocouple types
    - For example K-type, with Chromel-Alumel wires
- Products available that cover all Thermocouple types and temperature ranges
- Ideal during product development

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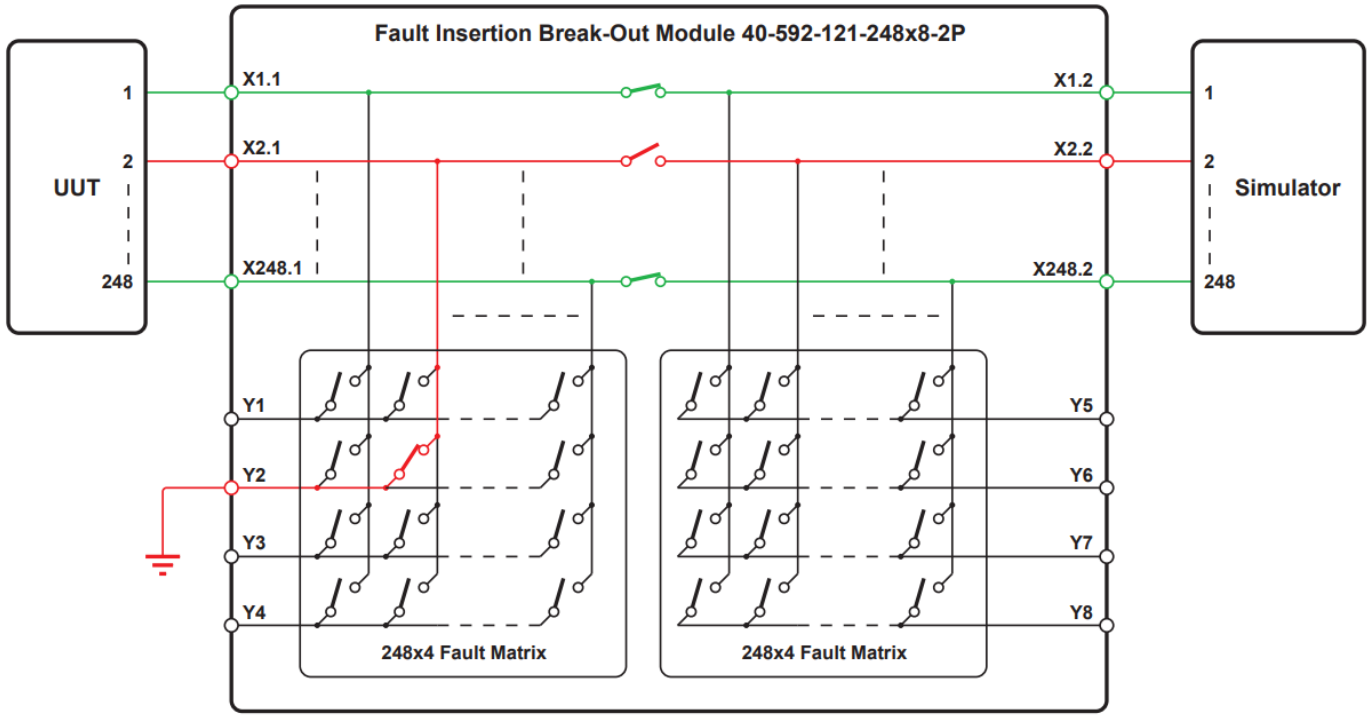
Fault Insertion/Fault Injection

- Designed specifically for safety-critical applications where the behavior of a control system, such as a BMS, needs to be fully evaluated
- Simulates open circuits, short circuits and unwanted connections
  - To another signal, component, power or ground, including high resistance connections



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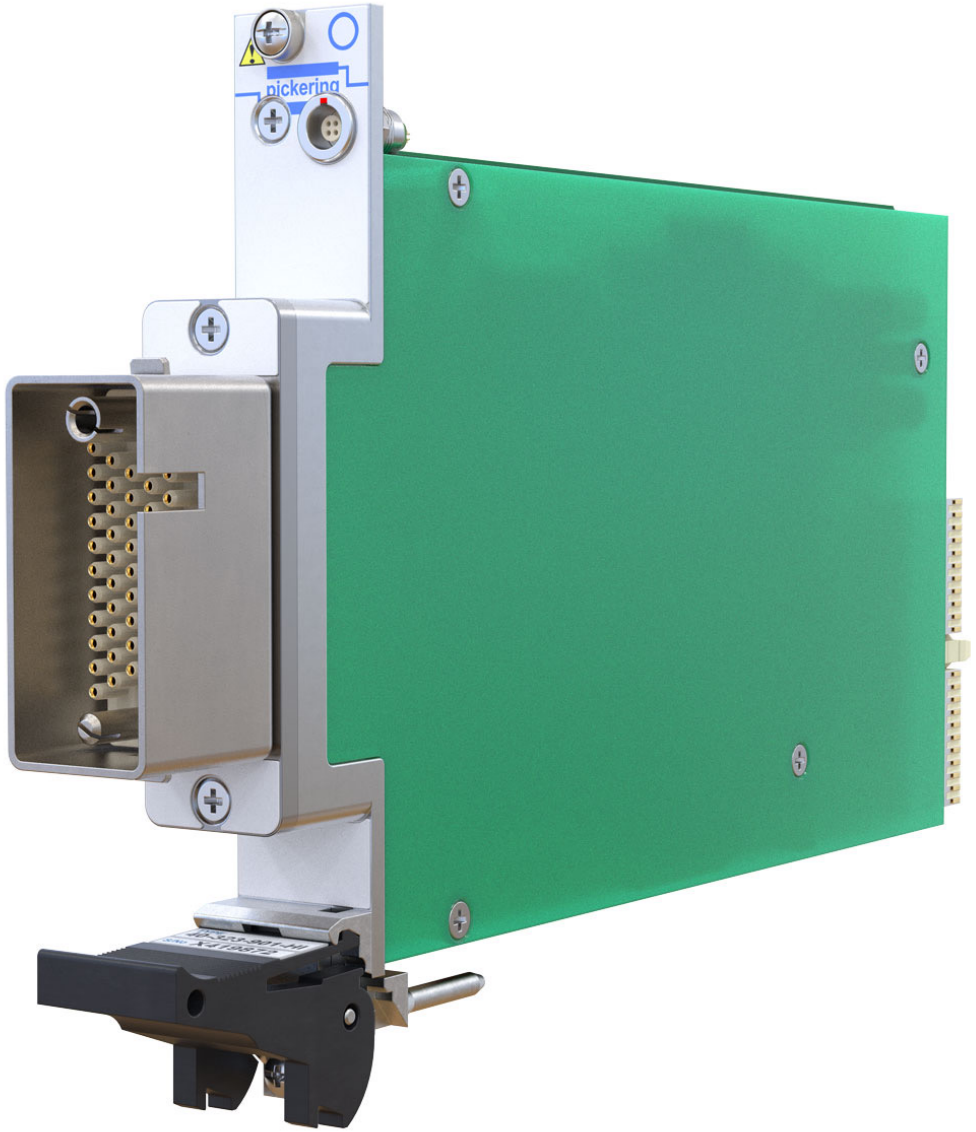
High Voltage Switching

- Many forms, including uncommitted, multiplexers and matrices
- Application specific
- Different voltage options, from low voltage to kilovolts
- Hot switching or cold switching
- Ideal for any application requiring switching, including isolation and breaker simulation



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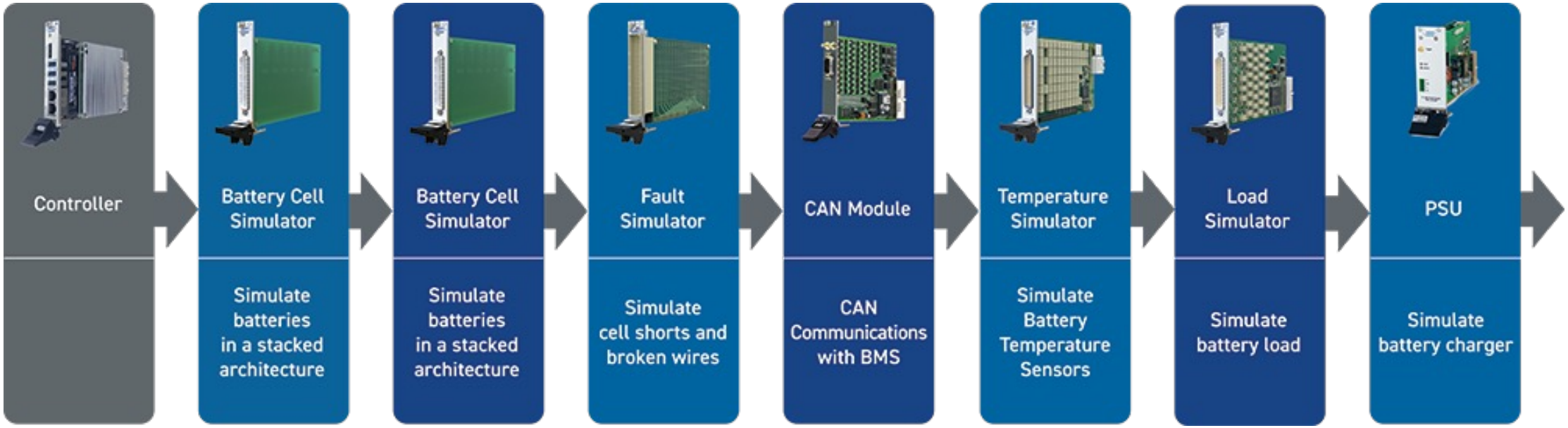

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Q&A

For more information go to PickeringTest.com/EV

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