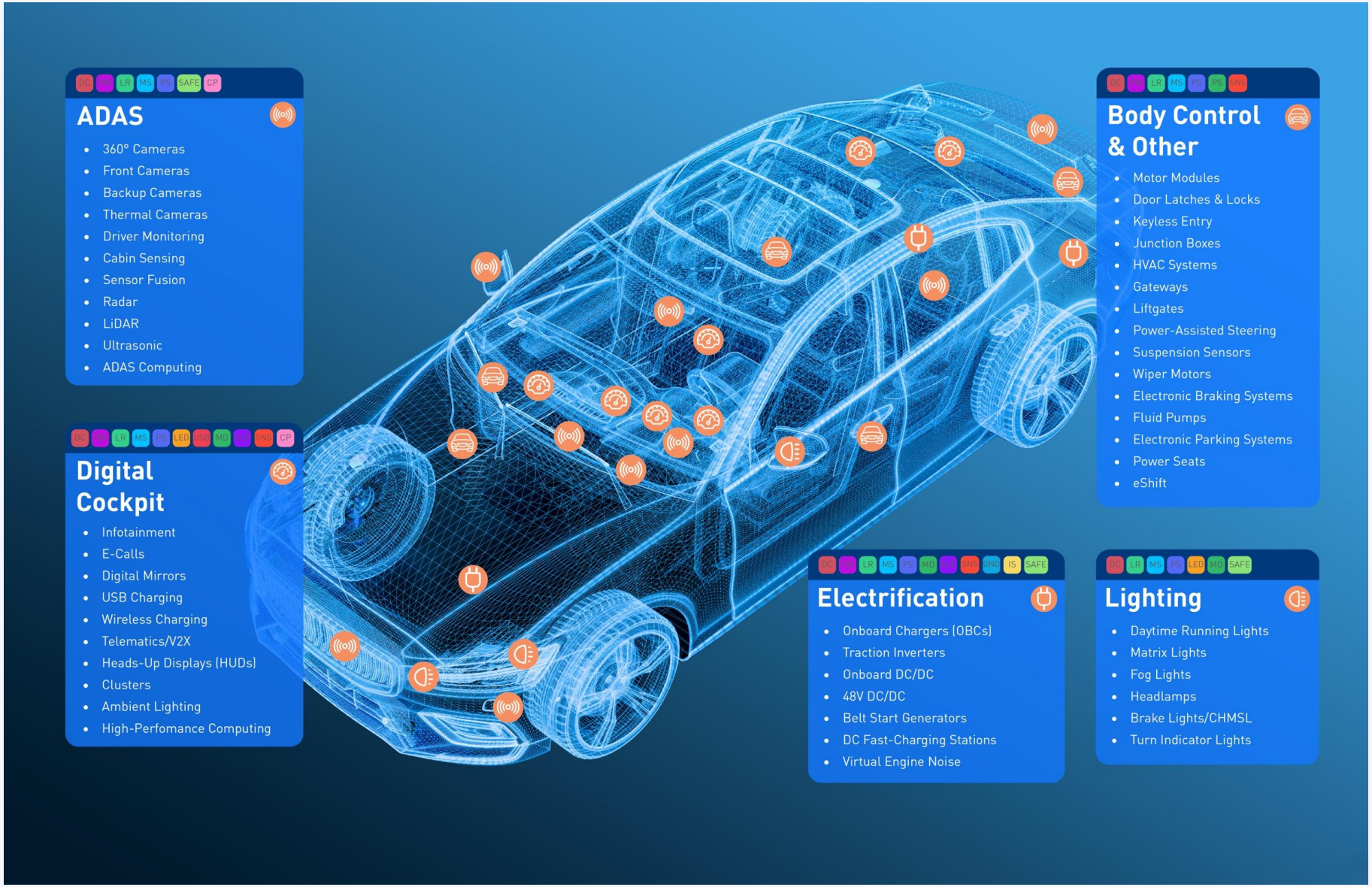
Innovative 48V E-Fuses: Intelligent, Integrated Protection for the Software Defined Future

February 2026

Topics

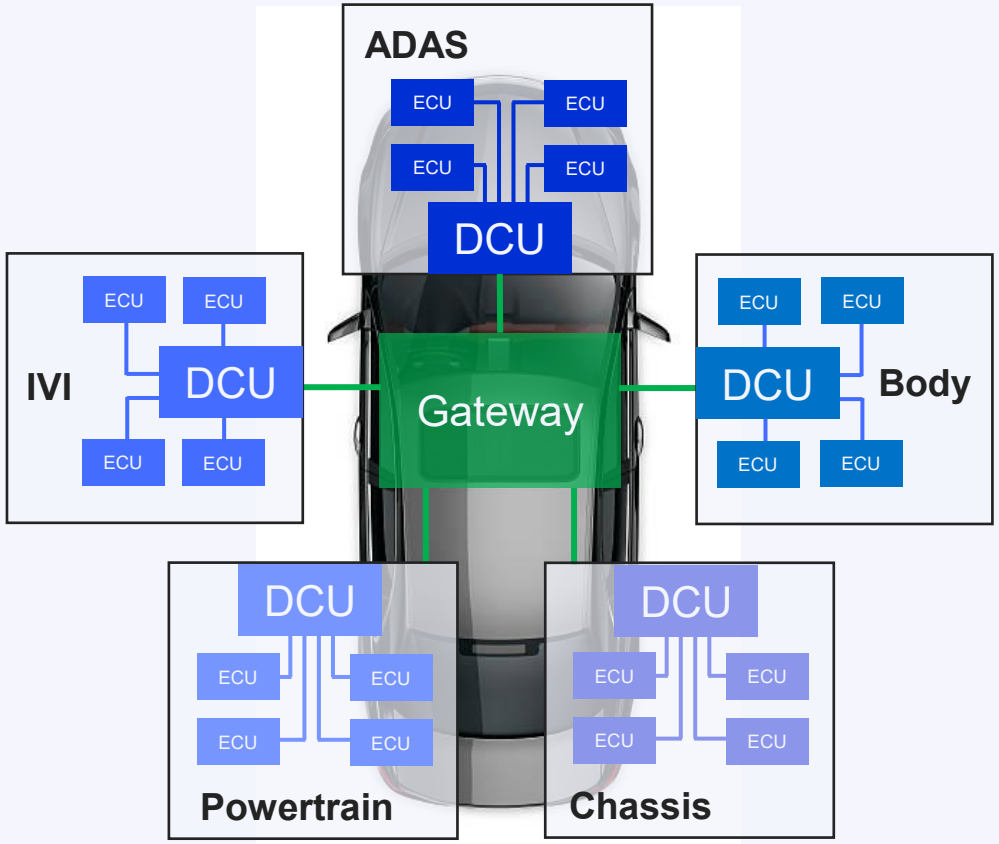
- The Limitations of Conventional Car Systems
  - 12V + Domain Architecture + Mechanical Fuse
- Future Trends for Safer, Smarter, and More Efficient Car Systems
  - 48V + Zonal Architecture + E-Fuse
- MPS Integrated 48V E-Fuse Solution

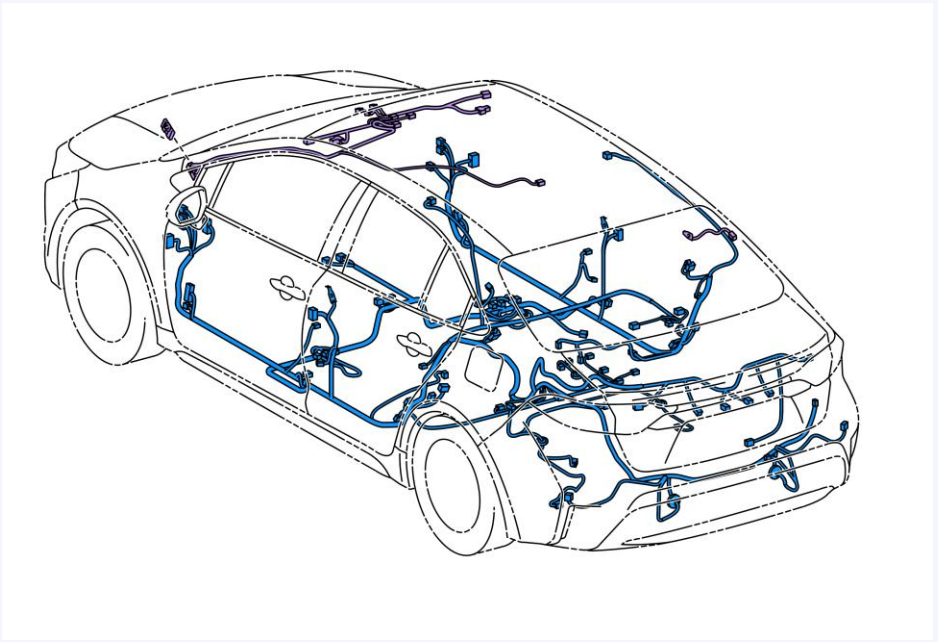
The Car of Today Is an Electronics Wonderland



Conventional Domain Architecture

Domain Architecture

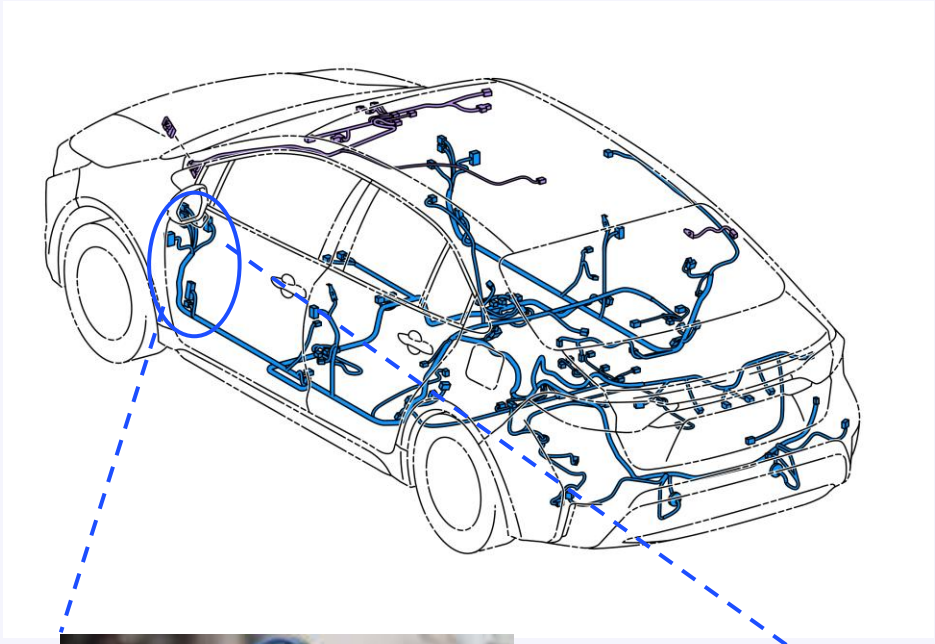




Group ECUs Based on Function, Not Location

Complex, Long Wiring Harness

The Function of Mechanical Fuses

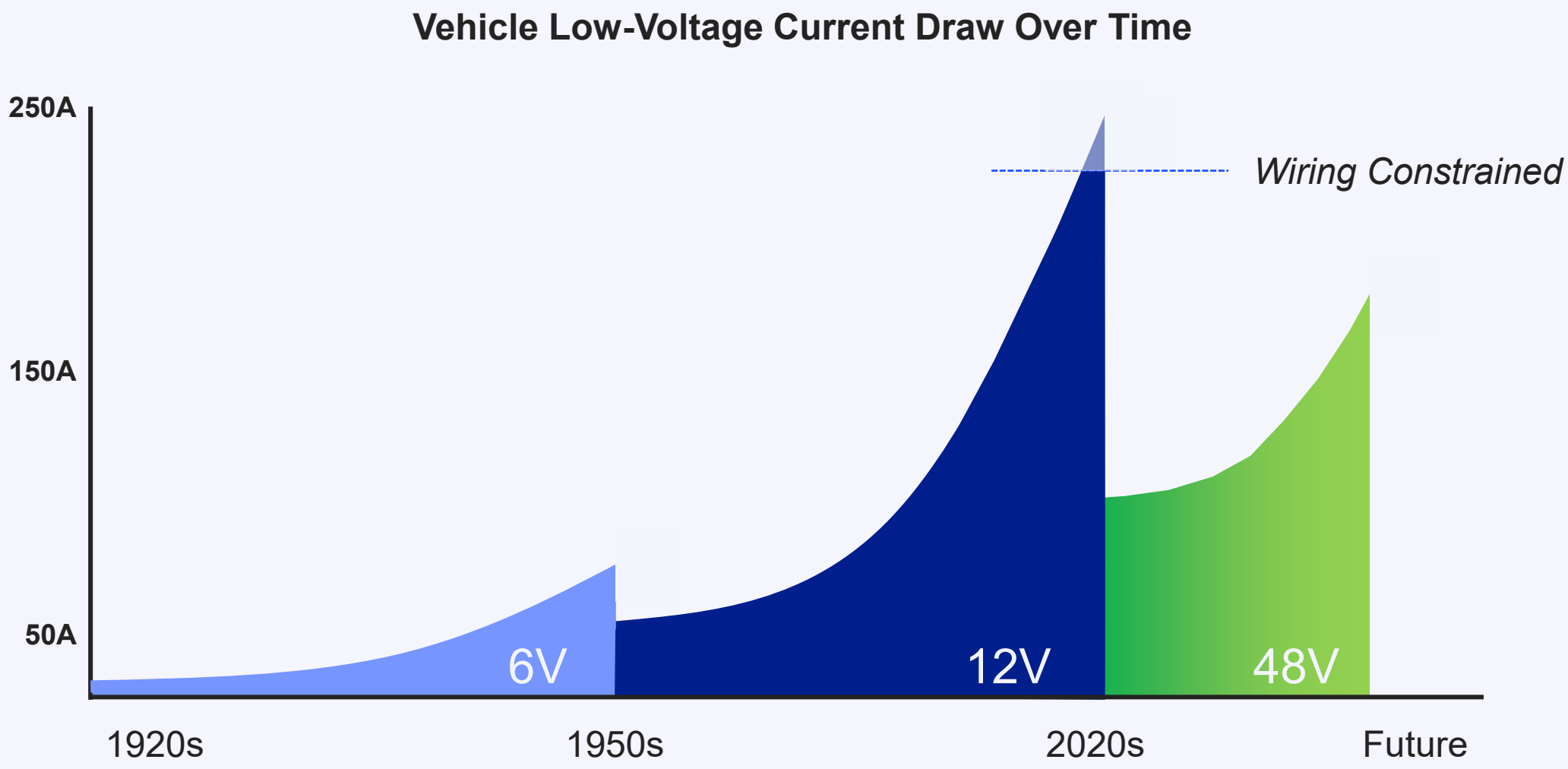


The Function of Mechanical Fuses:

- Protect wires from heating up
- Protect electronic units from fault condition, e.g. short circuits
- Fault isolation
- Diagnostic utility

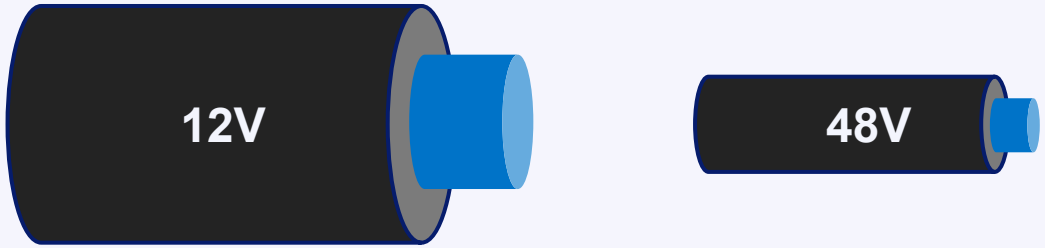
Future Cars – Your Second Living Room

Change Is Overdue



Wire Savings

600W Load Example



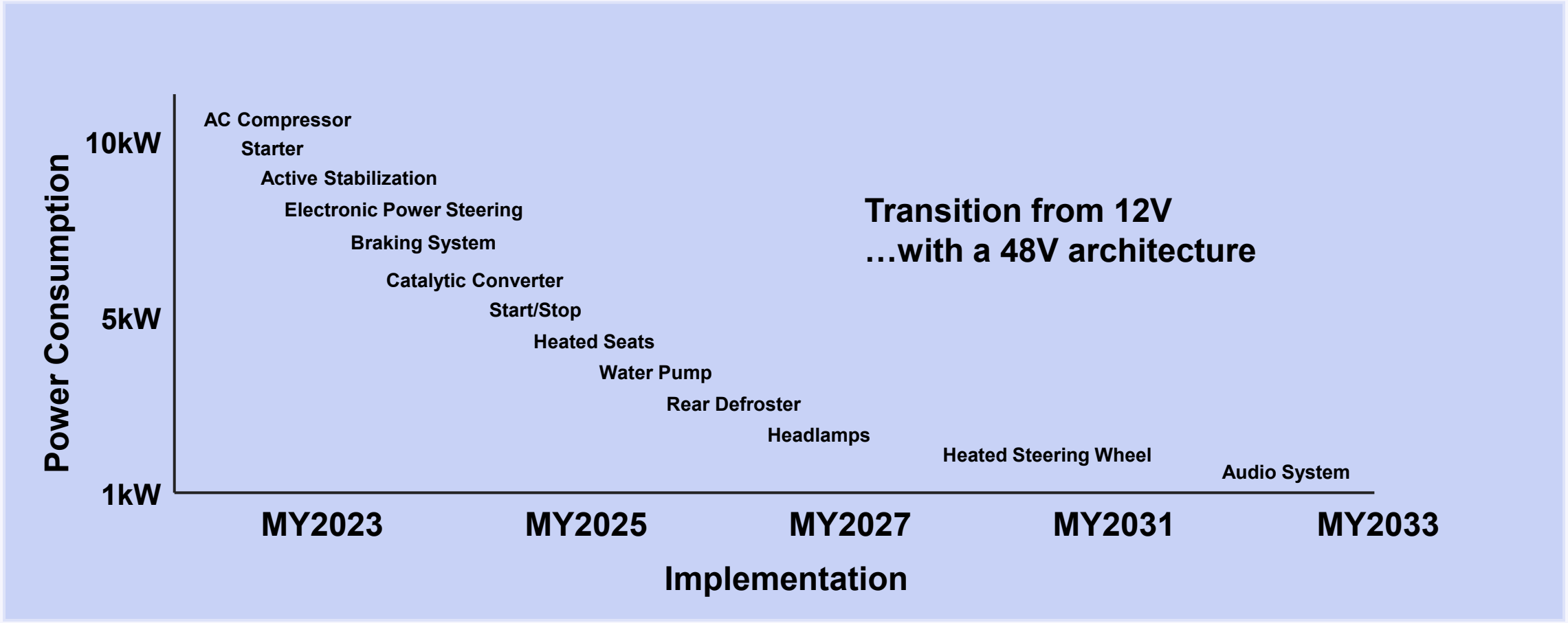
12V		48V
50A		**12.5**A
10mm²		**1.5**mm²
108g/m	Kg	**17**g/m
4.5W/m		**1.9**W/m

» 80%
Smaller Size

» 80%
Weight Reduction

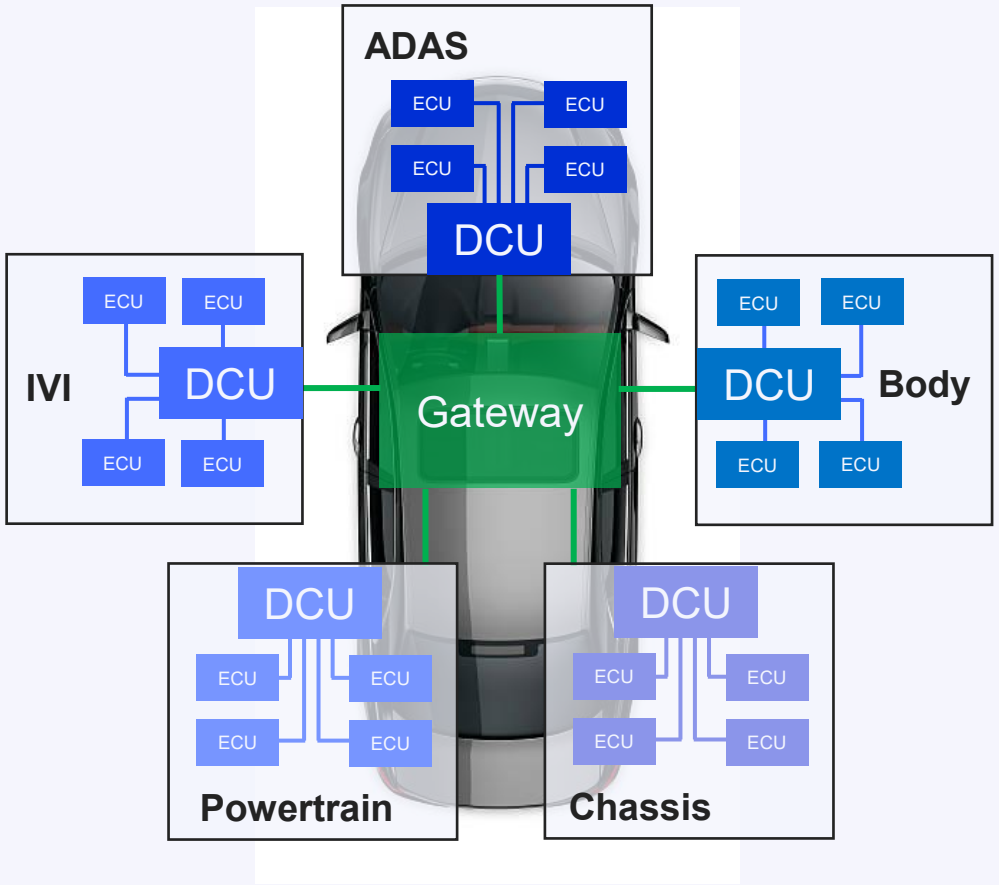
» 50%
Less Loss in Wiring

48V Is the New 12V



Shift from Domain Architecture to Zonal Architecture

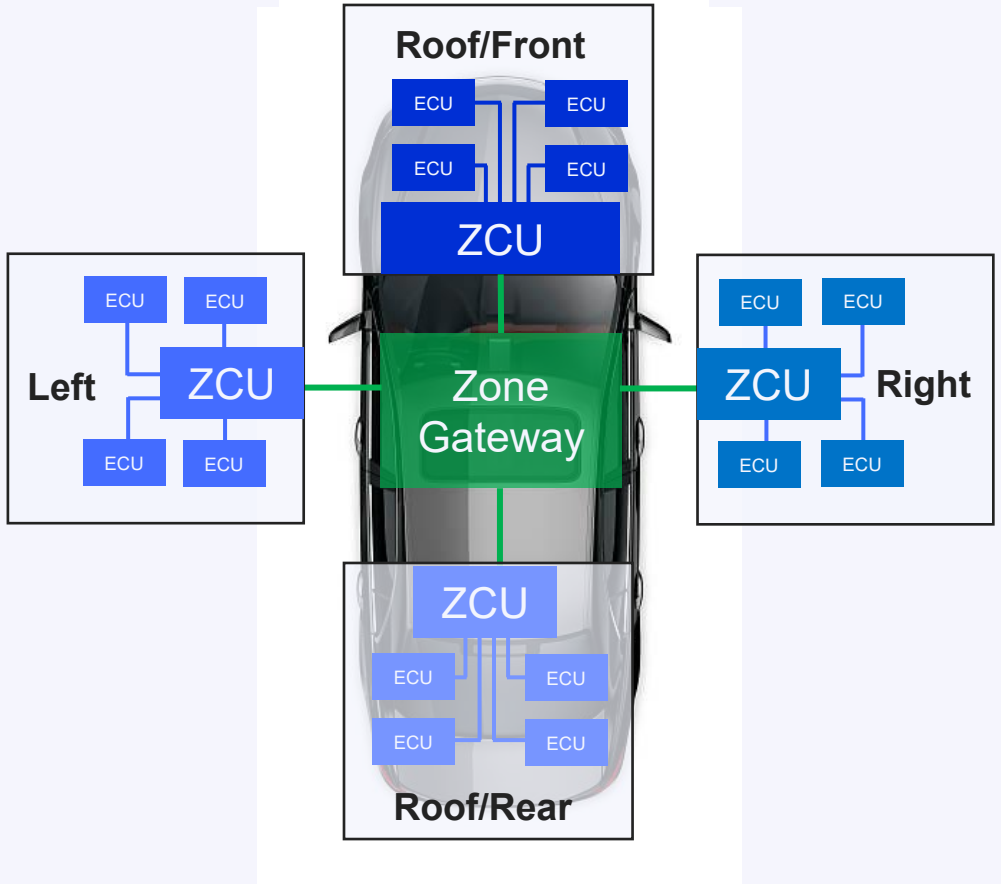
Domain Architecture



Group ECUs Based on Function:

- Complex, Long Wiring Harness
- Large Communication Delay

Zonal Architecture



Group ECUs Based on Physical Location:

- Simple, Short Wiring Harness
- Small Communication Delay
- Central Computer Enables Software-Defined Vehicle

Shift from Mechanical Fuse to E-Fuse

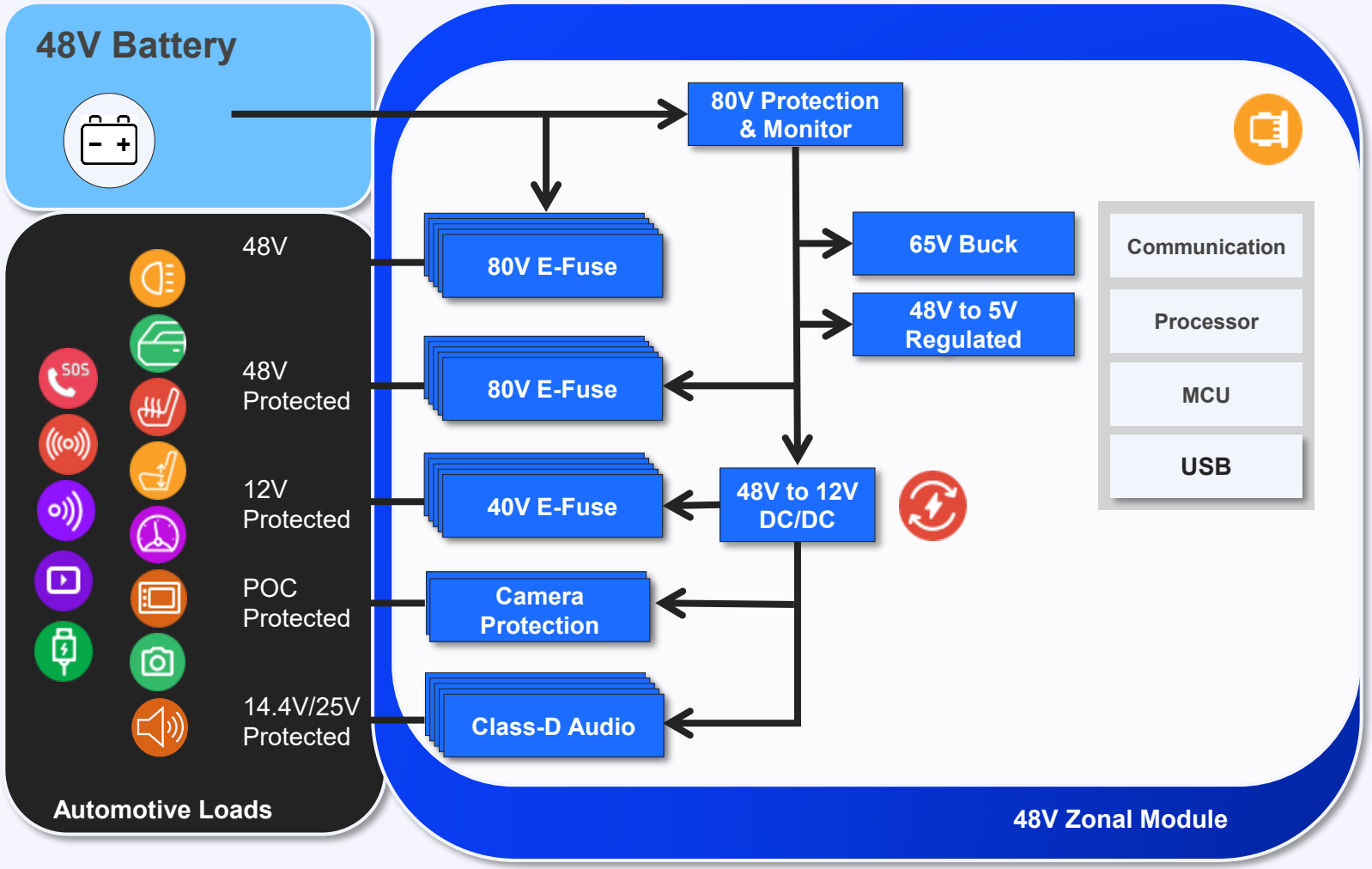
Traditional Mechanical Fuse

E-Fuse (Electronic Fuse)

- Slow Response with High Fault Tolerance
- Non-Resettable
- No Additional Protection Features
- No Diagnostics
- Centralized Power Distribution

- Faster Response with Tighter Fault Tolerance
- Resettable
- Protects Against Harmful Voltage and Temperature
- Vast Diagnostic and Monitoring Feature
- Decentralized Power Distribution

Architecture of 48V Zonal Control Unit with E-Fuse



- Wire Saving with 48V and Zonal
- Faster Communication Speed
- Vast Protection and Diagnostics
- Scalable
- Easy to Upgrade

Software-Defined Vehicle:

Safer, Smarter, More Efficient

Challenges for 48V E-Fuses

Traditional Mechanical Fuse

E-Fuse
(Electronic Fuse)

- Joule Heating Principle
- No Electronics, No Power Consumption
- No Expectation for Additional Protection and Diagnostics

- How to Mimic Mechanical Fuse Behavior in Semiconductor Devices?
- How to Reduce Power Consumption?
- How to Integrate All Protections and Diagnostics?
- Scalable, Cost-Effective with Compact Size

MPQ5884-AEC1

80V, 4.5mΩ, E-Fuse and Smart High-Side Power Switch

Features

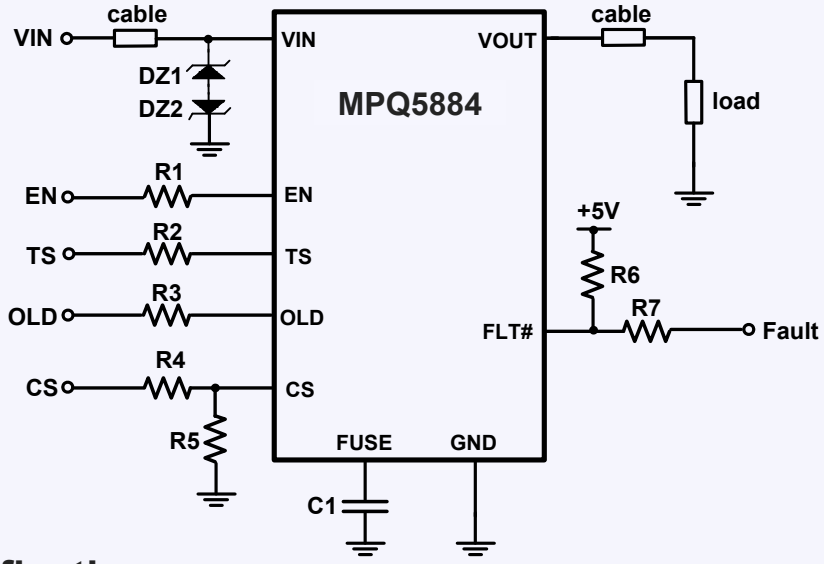
Built to Handle Tough Automotive Transients
- Load Dump Up to 80V
- -60V Continuous Reverse Voltage Self-Protection

Cooler Thermals
- 4.5mΩ On Resistance ($R_{DS(ON)}$)

Extends Vehicle Battery Life
- 25uA Low Quiescent Current (I_Q) Mode
- Extremely Low Shutdown I_Q

Built-In Protections and Monitoring
- Highly Accurate Current-Sense and Reporting
- Fuse-Like Over-Current Protection (OCP) and Short-Circuit Protection (SCP)
- Self-Protection during Reverse Battery Condition
- Fault Reporting
- Open-Load Detection
- Thermal Monitoring
- Thermal Shutdown

Additional Features
- EN Pin Supports 3.3V or Battery Connection
- Available in AEC-Q100-012 Test Grade A



Key Specifications

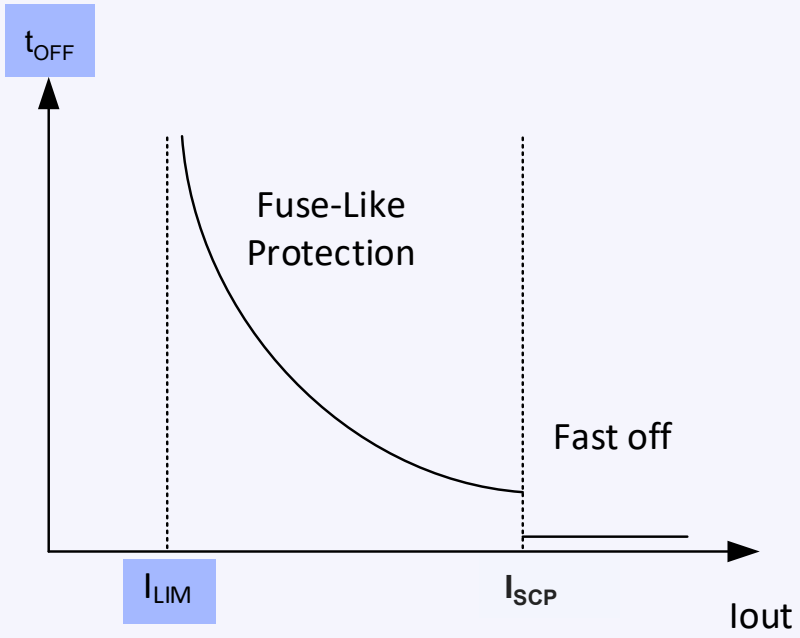
6V to 80V	**-60V to +80V**	**4.5mΩ**	15A	QFN-30 (5mmx6mm)
Recommended Operating Range	**Protected Input Range**	**$R_{DS(ON)}$**	**Nominal Current**	**Package**

Versions

MPQ5882	**2.5mΩ**	25A	PQFN-30 (6mmx8mm)
MPQ5884	**4.5mΩ**	15A	QFN-30 (5mmx6mm)
MPQ5887	**7.5mΩ**	10A	QFN-30 (5mmx6mm)
MPQ5889	**15mΩ**	7A	QFN-30 (5mmx6mm)
Part Number	**$R_{DS(ON)}$**	**Nominal Current**	**Package**

Fuse-Like Over-Current Protection and Short-Circuit Protection

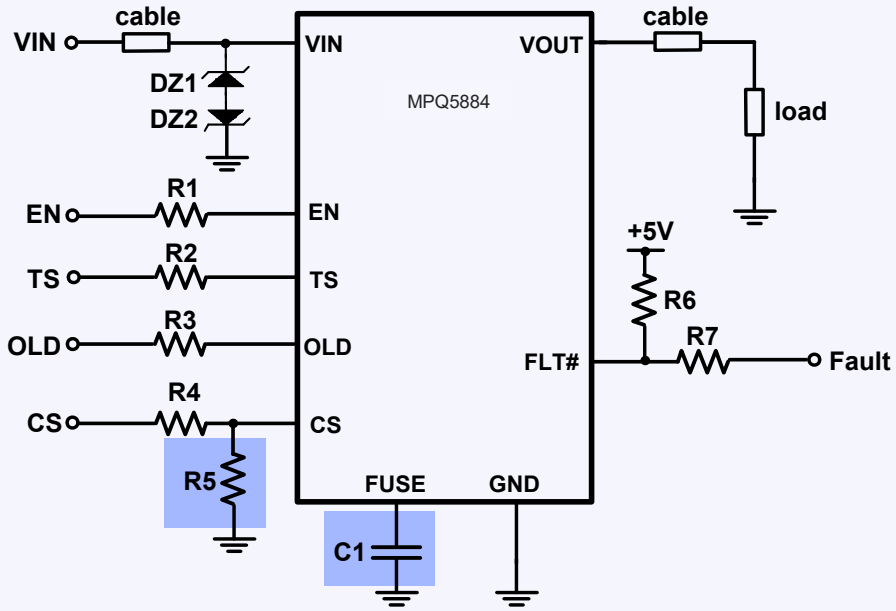
MPS Proprietary Fuse-Like Protection



The greater the load current, the shorter the fusing time and the sooner the e-fuse MOSFET turns off.

Mimics mechanical fuses with controllable fusing time variance.

Hardware-Configurable Fuse Curve

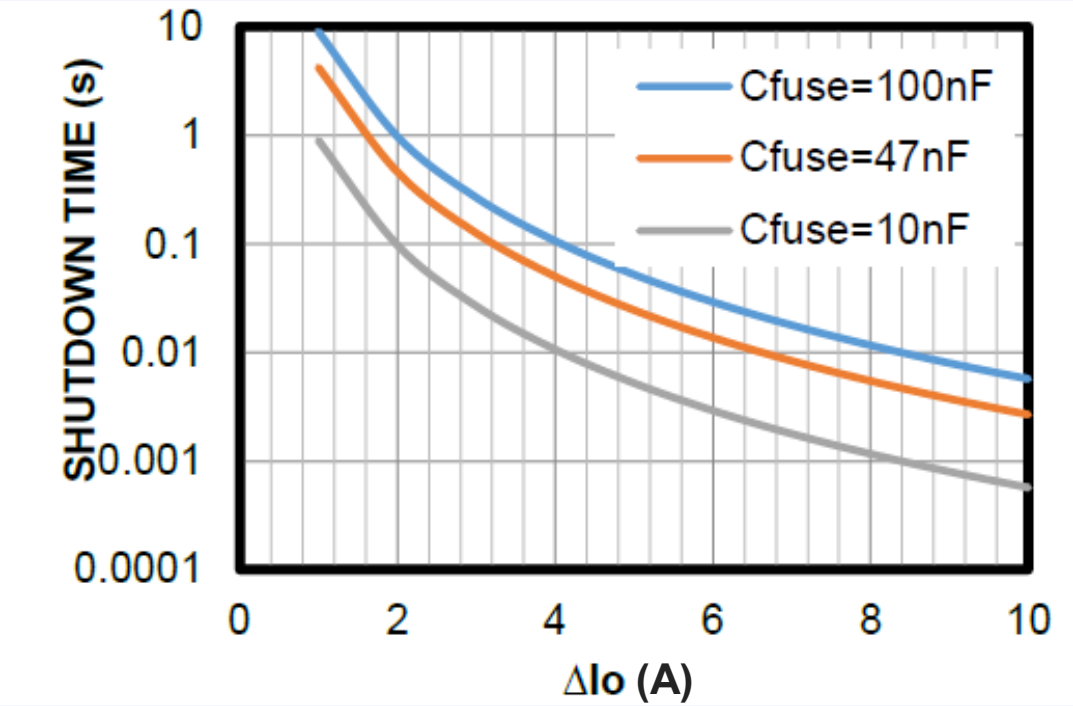


R5 determines the fuse current starting point (I_{LIM}).

C1 determines the fuse protection turn-off time (t_{OFF}).

Fuse-Like Protection Test Waveform

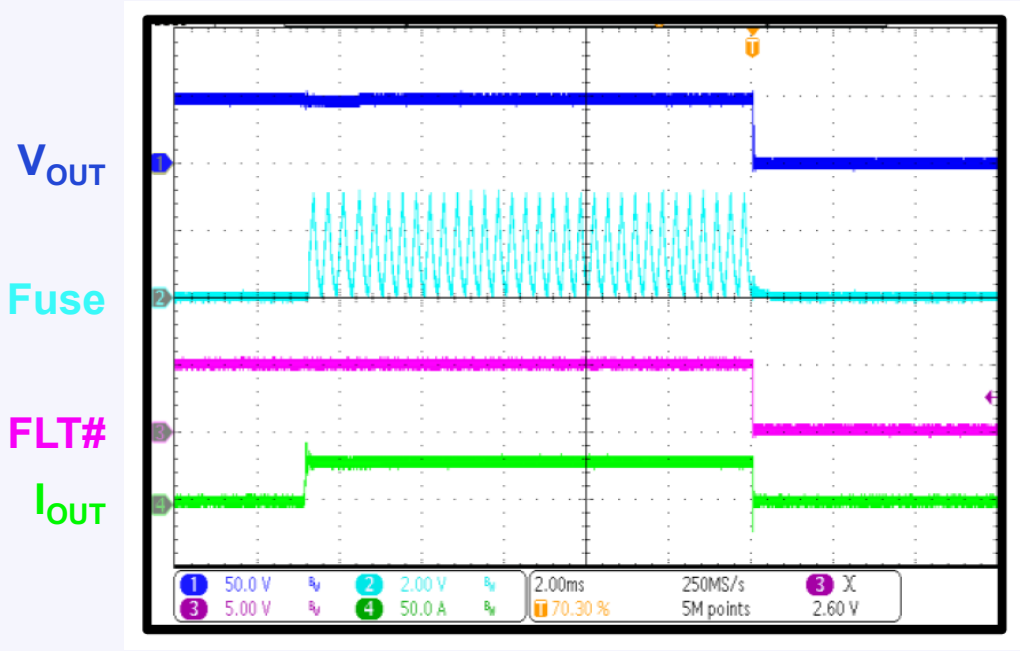
Hardware-Configurable Fuse Curve



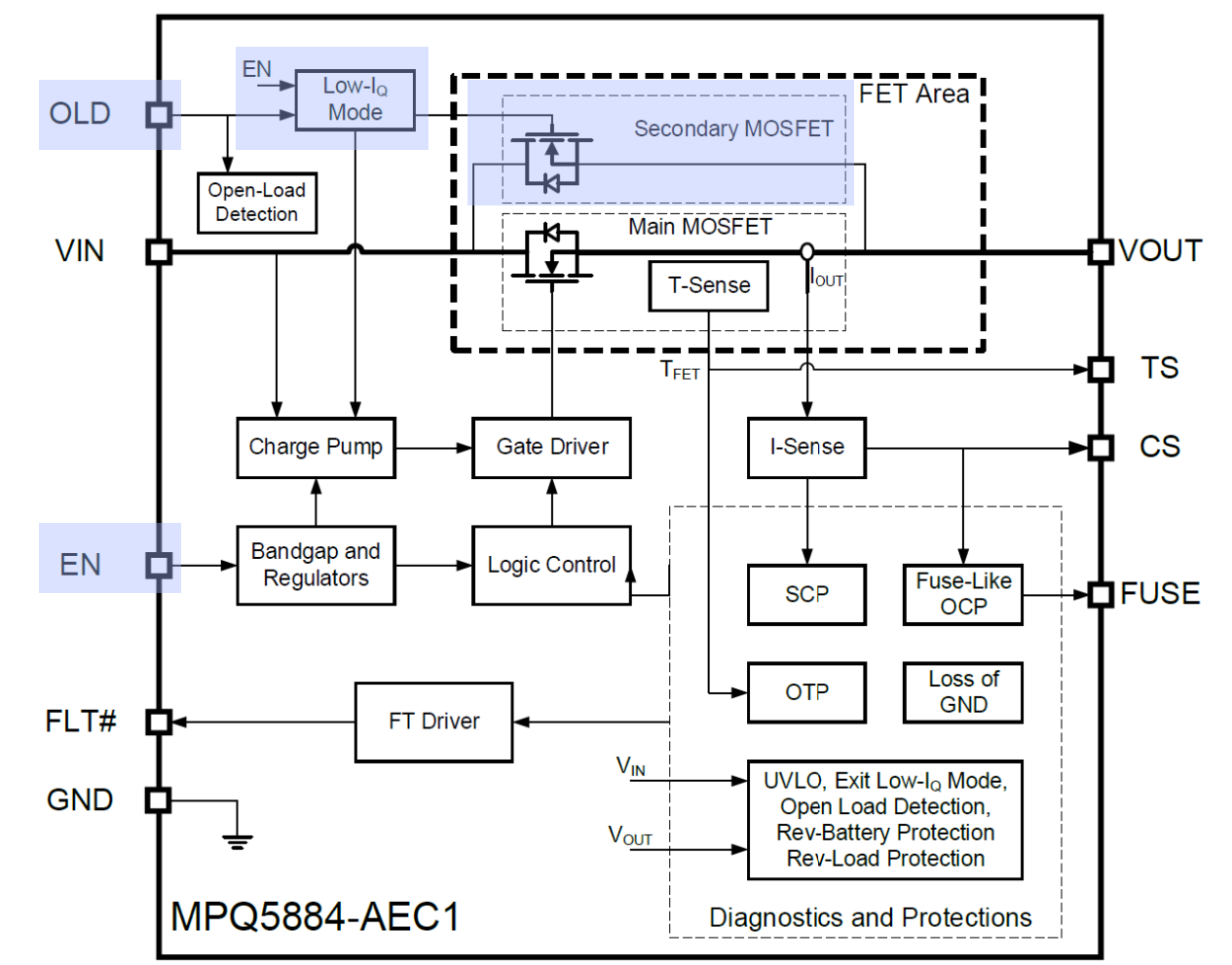
*Note:$\Delta I_o = I_o - I_{LIM}$

Test Waveform

I_{LIM} = 15A, I_{OUT} = 25A, Δi_o=10A:



Low Quiescent Current (I_Q) Mode

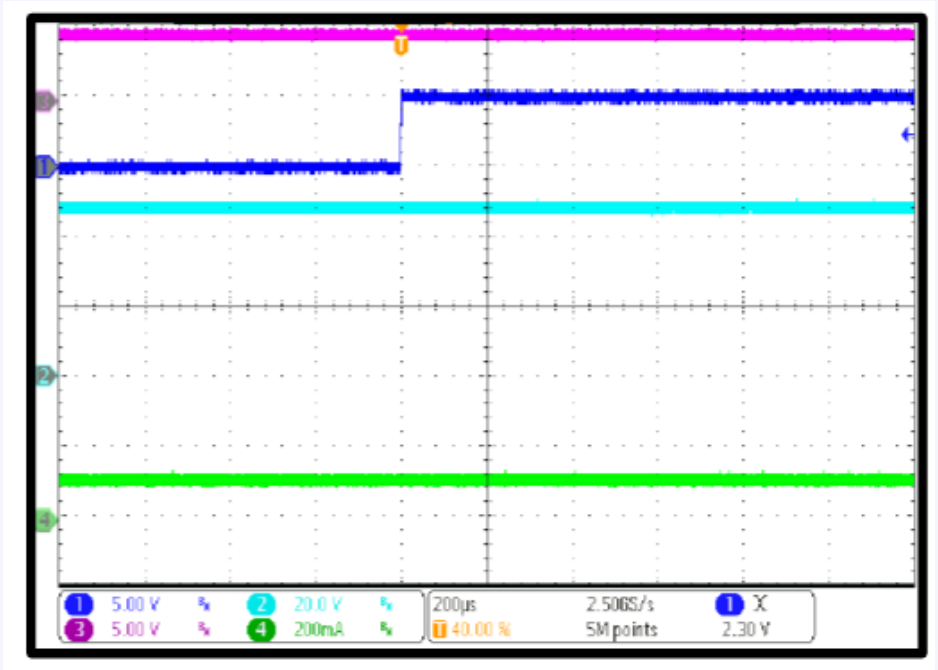


- Secondary MOSFET for Low-I_Q Mode
- Actively Toggle OLD Pin to Enter Low-I_Q Mode
  - EN = high, OLD = high
- Automatically Exits Low-I_Q Mode and Transitions to Normal Mode when the Load Current Increases, FLT# Pin Goes Low For System Report

Low-I_Q Mode Test Waveform

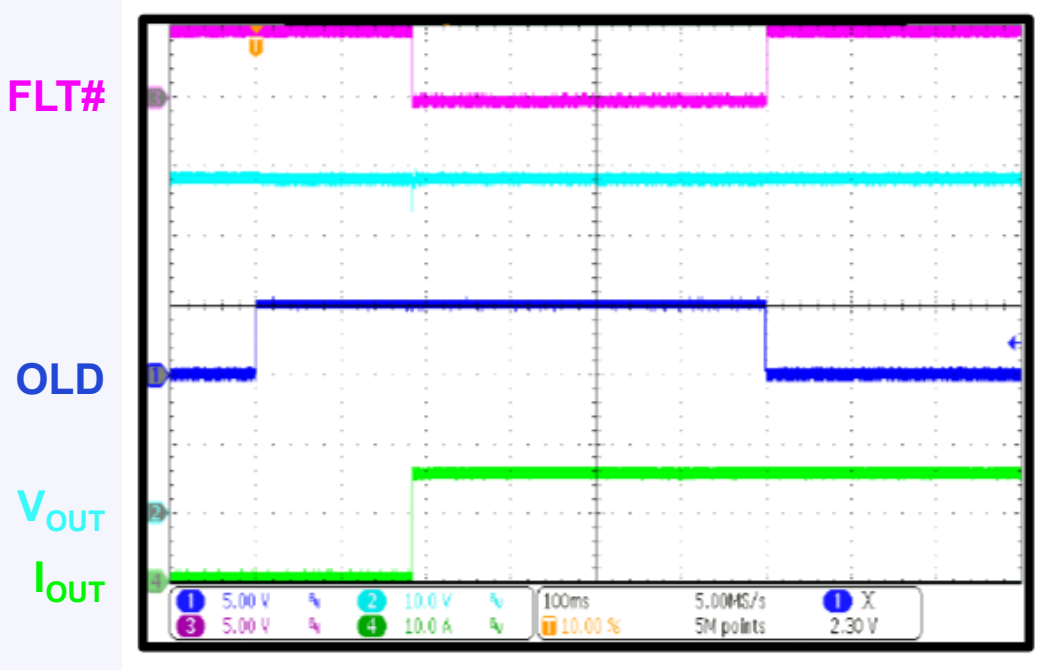
Low-I_Q Mode Entry

I_{OUT} = 0.1A



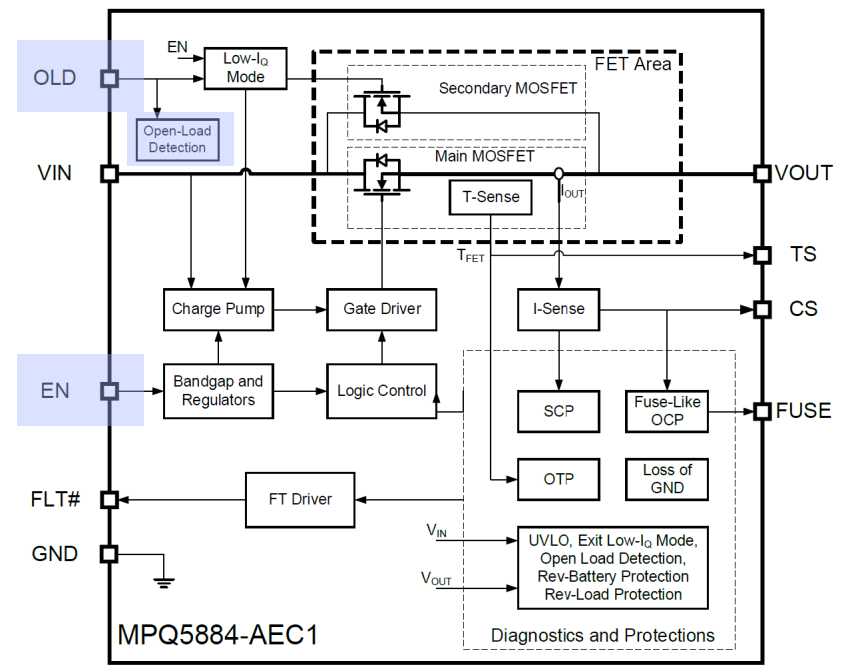
Automatic Low-I_Q Mode Exit

I_{OUT} = 0.1A to 15A

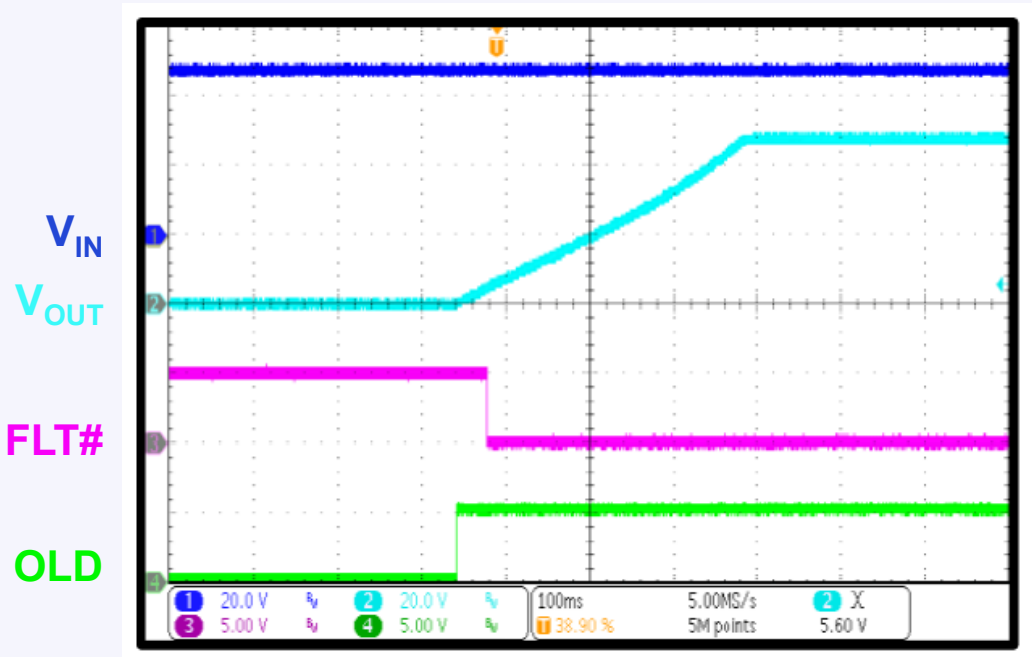


Open-Load Detection

Open-Load Detection Mechanism

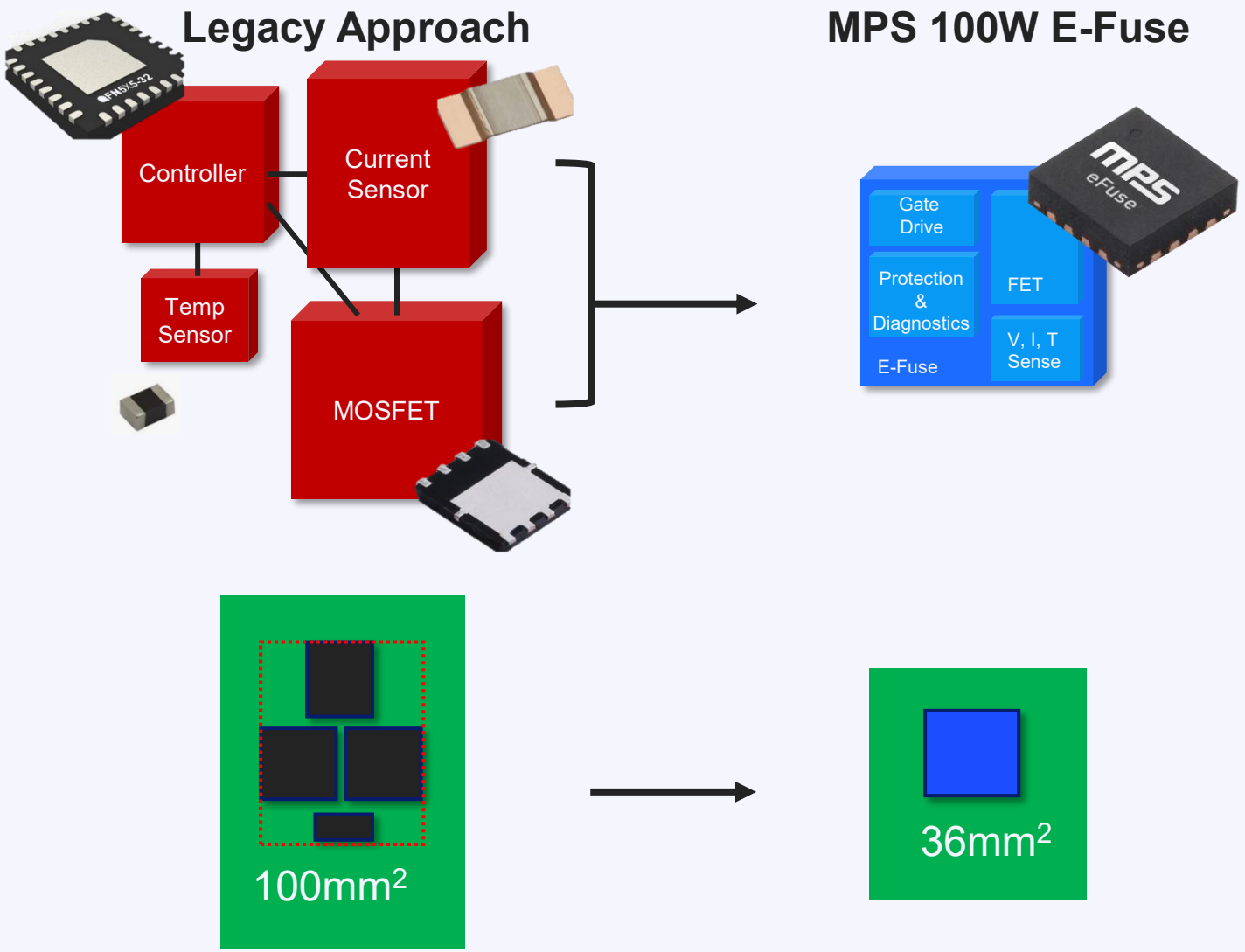


Test Waveform



- **Open-Load Condition:**
  - **High Impedance Due to Bad Wire Connection**
  - **Short to Battery**
- **Detection Mechanism:**
  - **Current Sourced by the VOUT Pin**

Benefits of MPS Integrated 48V E-Fuses



Integration Unlocks Massive Benefits

- Precision-Tuned
- Faster Response
- Vastly More Reliable
- Total System Monitoring
- Major Size Reduction
- Safety Capable

Takeaways

- **The Limitations of Conventional Car Systems**
  - 12V + Domain Architecture + Mechanical Fuse
- **Future Trends for Safer, Smarter, More Efficient Car Systems**
  - 48V + Zonal Architecture + E-Fuse
- **The Benefit of MPS Integrated 48V E-Fuse**
  - Fast Response Time with Tight Fault Tolerance
  - Protection and Diagnostic Features: Open-Load Detection, Current Sense, Temperature Sense, and More
  - Low-I_Q Mode to Extend Battery Life
  - Integrated Solution with Compact Size

Thank you!