Technical Article

Eight Questions about Monitoring and Protection in Hybrid and Electric Vehicles

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Collectively, we're engaged in a worldwide effort to reimagine automotive and reduce emissions, whether it's helping carmakers offload combustion engines or transition to fully electric fleets. Electrification has proven to be the most adaptable tool for reducing emissions, but as voltage increases within vehicles, as shown in Figure 1, so does the significance of monitoring and protection subsystems.

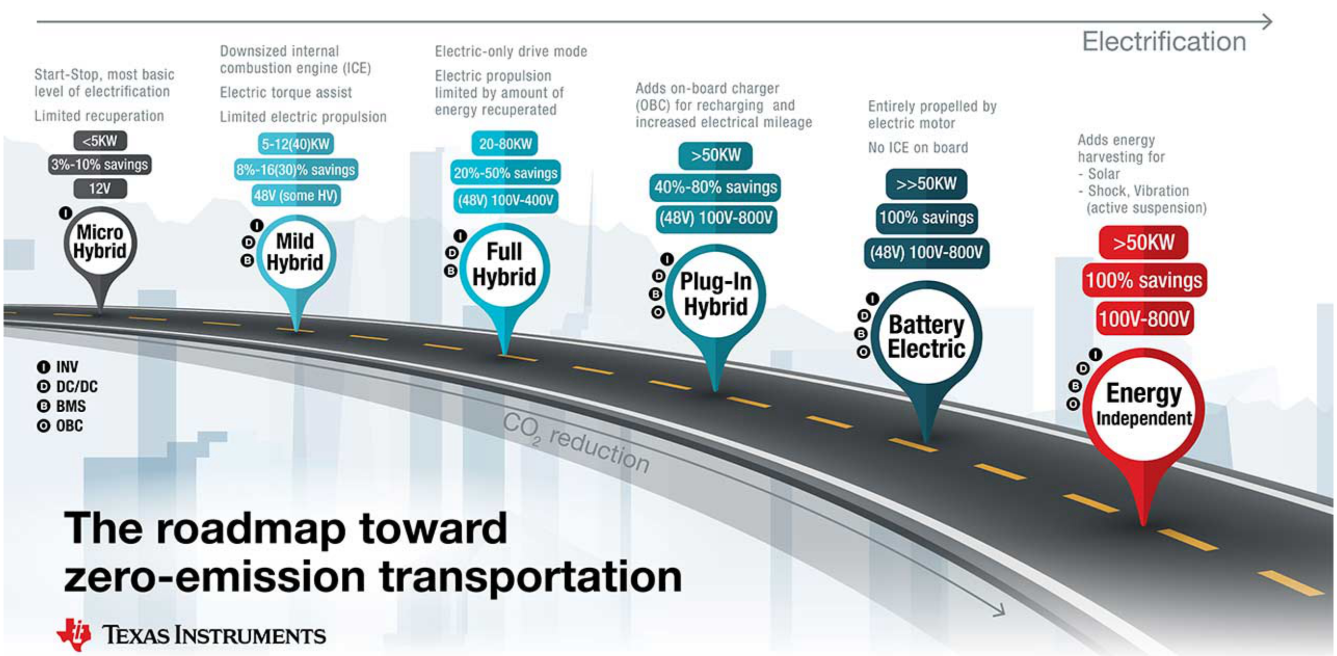

Figure 1. The Range of Hybrid to Electric Vehicles

Through recent advancements in monitoring and protection subsystems, we can speed time to market while maximizing drive time and keeping passengers safe in hybrid electric vehicles/electric vehicles (HEVs/EVs). Here are eight common questions about monitoring and protection in battery management systems and traction inverter systems.

1. How Can You Increase Energy Density and System Efficiency to Help HEVs/EVs Drive Farther and Longer?

Doubling the power output for the same size results in significant cost savings and also helps with fast charging. This is accomplished by operating the power converters (PFC stage and DCDC in an OBC or fast DC charger) at high switching frequencies, which reduces the size of the magnetics, thereby helping achieve high power density. Higher system efficiency means lower losses and a smaller heat-sink solution for a given application. It also reduces the thermal stress on devices and contributes to a longer life expectancy.

2. How Can HEVs/EVs Give Drivers the Same User Experience as Cars Powered by an Internal Combustion Engine?

The driving experience will be improved by increasing the available mileage per charge while at the same time reducing the charging time. Achieving these goals requires a state-of-the-art battery management system and high-efficiency power electronics on both the car and the grid infrastructure (charging pile) side.

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3. How Can You Improve the Reliability of HEV/EV Battery Management Systems?

The BQ79606A-Q1 is designed to boost reliability with these features:

- A voltage monitor, temperature monitor and communication functions up to Automotive Safety Integrity Level (ASIL)-D.
- An optional daisy-chain ring architecture to ensure stack communication even in the event of a broken communication cable (limp-home mode).
- A design that enables robust hot-plug performance without the need for external Zener diodes.

4. How Can Automotive Designers Solve the Poor Discharge Performance of Lithium-ion Battery Packs Used in Cold Temperature Environments?

Battery packs of hybrid and electric cars work within a controlled temperature range to optimize charge/discharge performance at low temperatures and to make sure that the battery stays within the safe operating area at higher temperatures. Accurate voltage and temperature sensing on the cell/pack level (as featured on the BQ79606A-Q1) is necessary in order to apply appropriate thermal management strategies. These might entail preheating at cold start conditions and of course cooling at higher temperatures.

5. What’s One Way to Monitor BMS Systems?

In a daisy-chain configuration, the Scalable Automotive HEV/EV 6s to 96s Lithium Ion Cell Supervision Demonstrator Reference Design implements the BQ79606A-Q1 to create a highly accurate and reliable system design for three- to 300-series, 12-V up to 1.2-kV lithium-ion battery packs. The design is scalable across six to 96-series cell supervision circuits and communicates the battery’s voltages and temperatures to help meet ASIL-D requirements.

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6. What Are the Advantages of Using Silicon Carbide (SiC) or Gallium Nitride (GaN) In-vehicle Devices in Traction Inverters?

New developments in SiC power circuits can help designers develop more efficient, lighter and more intelligent EV powertrain systems, such as traction inverters, on-board chargers and fast DC-charging stations. Devices such as the new UCC21710-Q1 and UCC21732-Q1 are the first isolated gate drivers to integrate sensing features for insulated-gate bipolar transistors (IGBT) and SiC field-effect transistors, enabling greater system reliability and providing fast detection times to protect against overcurrent events while ensuring safe system shutdown.

7. Is It Possible to Prevent Overheating in a Traction Inverter?

The TMP235-Q1 helps traction inverter systems react to temperature surges and apply appropriate thermal management techniques with low power, small footprint and high accuracy. Learn more about temperature monitoring when designing a traction inverter in the e-book, “Temperature monitoring and protection.”

8. Why Do You Need Temperature Sensors for Traction Inverter System Reliability in HEV/EV Vehicles?

Thermal management is a crucial parameter to guarantee EV performance as well as passenger safety. It ranks high among the priorities of automotive original equipment manufacturers in order to reassure consumers how safe these novel modes of transportation are in comparison with their internal combustion counterparts.

The better the accuracy, the better chances the system will react to temperature surges quickly by applying appropriate thermal management techniques.

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According to the International Energy Agency, the number of electric vehicles on the road is estimated to triple by 2021; so will the need for state-of-the-art monitoring and protection. So let’s get back to work. We’ve got a lot of cars to design and big expectations to fulfill.

Additional Resources

- The HEV/EV Traction Inverter Power Stage with 3 Types of IGBT/SiC Bias-Supply Solutions Reference Design demonstrates three types of IGBT/SiC solutions.

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