Why EVs don't need 12V lead acid batteries

The continuous advancement of lithium-ion battery technology has given EVs longer driving range, faster acceleration and more horsepower than ever before. So why are most EVs still carrying a 12V lead acid battery for standby power? By **Power Integrations**

Inexpensive and dependable, lead acid batteries have been around for more than 100 years, including being used in the early versions of electric vehicles back in the 1890s. It offers the high current (500A in cold conditions for up to five seconds) needed to start an internal combustion engine, and the entire electric subsystem of an ICE (internal combustion engine) vehicle has been designed to be powered by the 12V battery when the engine is turned off.

As the auto industry began electrification in the late 1990s with hybrid or plug-in hybrid electric vehicles, a lead-acid battery is still needed because there is still a gasoline engine to be started.

Cars without engines

Even without the need for the 500A peak output current to start a gas engine, most fully electric vehicles retain the use of this heavy battery for supplying 12V power to all electric subsystems when the motor is not running. The idea of eliminating the 12V battery in a fully electric car might sound simple, but a few more issues need to be addressed before it can happen.

The first is cost. Lead-acid batteries are cheap. In most instances, it costs more to employ a DC/DC conversion system to turn 400V (from the battery pack) to 12V for all the lights, pumps, windows, power steering and the infotainment/navigation systems.

Second is complexity. Redesigning anything in a car is complicated, as automotive qualification alone can take years to complete. Lead-acid batteries offer proven durability and a relatively long lifespan. Designing an electric car to run low-voltage systems with a 12V battery simplifies engineering.

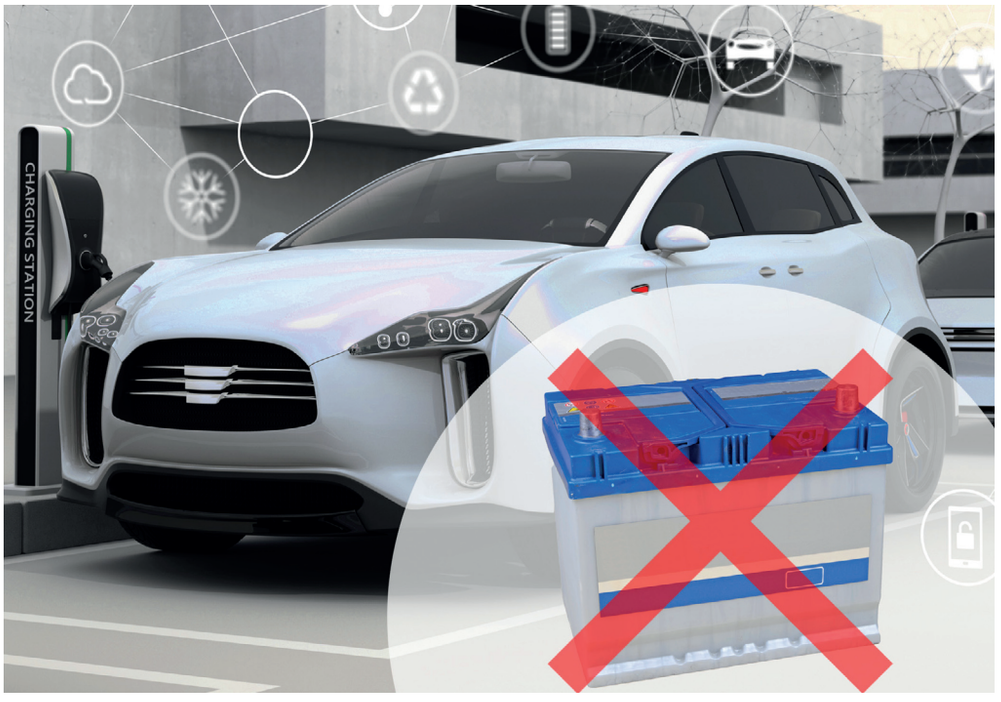
The third consideration is safety. Most of the low-voltage systems are in very close proximity to the passengers. The idea of drawing power directly from a 400V or 800V battery can be scary. Lead-acid batteries allow the higher voltage to be isolated by disconnecting the main battery back from critical systems. High voltage inside the passenger compartment would require many layers of safety protection. Instead of eliminating the 12V battery altogether, some recent EV designs replace the lead-acid battery with a much smaller and lighter lithium-based battery with lower available output current.

Rugged power supply

To completely eliminate the 12V battery requires a rugged power supply that can safely draw from the high-voltage battery packs. It needs to have a wide input voltage range, ideally 30V DC to 1000V DC, to cover both 400V and 800V nominal battery voltages, as well as 30V operation for functional safety critical applications.

It needs to be highly efficient to reduce operating temperature and minimise discharge of the traction battery. It also needs to have a low component count, which saves space and increases reliability.

Power Integrations' AEC-Q 100-qualified InnoSwitch3-AQ flyback switcher ICs with a 900V PowiGaN switch are suitable for such a power supply. The devices use a FluxLink feedback link, providing reinforced isolation up to 5,000V RMS for secondary-side control. The circuit will start from 30V without external circuitry, and the ICs achieve greater than 90% efficiency while



An EV's 12V battery can be eliminated with a rugged power supply that can safely draw from the HV battery packs.

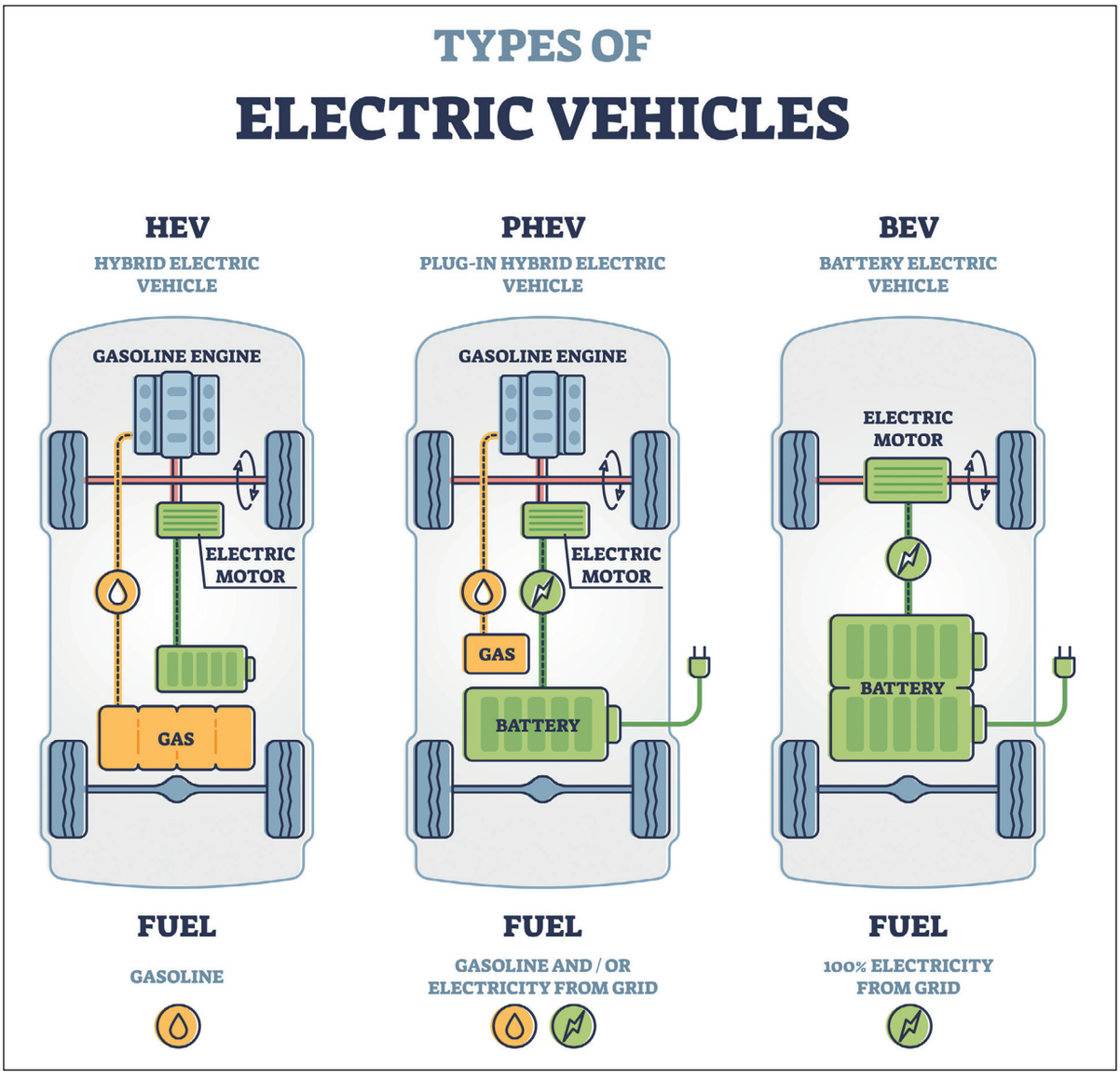


Figure 1: Definitions of EV types.

consuming less than 15mW at no-load, which is ideal for reducing self-discharge in battery management systems.

A new design example, DER-953Q, is now available for download on the company's website. This compact 100W power supply uses InnoSwitch3-AQ and eliminates the need for a 12V battery in EVs.

Innoswitch

The InnoSwitch family of ICs combines primary, secondary and feedback circuits in a single, surface mount off-line flyback switcher IC. The IC incorporates a high voltage, primary side switch, the primary side controller, a secondary side controller for synchronous rectification and FluxLink technology that eliminates the need for an optocoupler.

FluxLink communication technology enables feedback information to be delivered across an isolation barrier without the use of any magnetic materials. FluxLink delivers a high communication bandwidth which enables a much faster load transient response. This proprietary technology meets all global noise immunity standards. For safety, it complies not only with UL and TUV global isolation standards but also the more stringent CQC 5,000 metre Chinese safety standard.

InnoSwitch3-EP flyback off-line CV/CC QR flyback switcher ICs are available with a number of switch options: 725V and 750V

silicon, 900V and the recently released 1,250V PowiGaN gallium nitride (GaN) devices, and a 1,700V silicon carbide (SiC) device.

PowiGaN is Power Integrations' internally developed GaN technology. PowiGaN switches replace the traditional silicon transistors on the primary side, reducing switching losses and enabling power supplies that are more efficient, smaller and lighter than silicon alternatives, says the company. PowiGaN-based ICs achieve up to 95% efficiency across the full load range and up to 100W in enclosed adapter implementations without requiring a heatsink.

InnoSwitch3 designs' ability to offer exceptional light load efficiency makes them ideal for providing auxiliary power in electric vehicles during low power sleep modes. The AEC-Q100-qualified InnoSwitch3-AQ family is particularly suitable for EVs based on 400V bus

systems where the 900V PowiGaN switch provides more power and increased design margin - required for 12V battery replacement systems - with enhanced efficiency over silicon-based converters.

The 900V InnoSwitch3-AQ off-line CV/CC flyback switcher ICs employ synchronous rectification, a valley switching discontinuous conduction mode (DCM) and continuous conduction mode (CCM) flyback controller. PowiGaN technology enables automotive InnoSwitch3-AQ devices to deliver 100W from a 400V bus and provide performance and protection features similar to those of the popular 1,700V SiC InnoSwitch3-AQ ICs currently used in 800V EV systems. There are multiple protection features including line over- and under-voltage protection, output over-voltage and over-current limiting, and over-temperature shutdown.

Figure 2: Conventional EV design has to accommodate battery packs and the driver train.