Automotive 48-volt Technology

Close to reality: the series launch of the 48-volt power system

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Johneric has over twenty-one years' experience in the Automotive Industry and has worked in various areas including R&D, Design, Engineering, Manufacturing Planning and Program Management. His last role before establishing his own consultancy was working as a product line manager for a U.S. Automotive sensors company with specific responsibilities for vehicle dynamic (steering, chassis and braking) and transmission sensors. Johneric's academic achievements include receipt of a B.Des in Industrial Design (Eng.) from the University of Limerick/NCAD in 1990; directly after he completed a MSc. in Work Design and Ergonomics at the University of Birmingham. In 2012 Johneric was awarded an MBA from Edinburgh School of Business, Herriot-Watt University. With a firm belief in continuous education Johneric completed his Six Sigma green belt training in January 2015. Johneric has been a regular presenter at International conferences covering both commercial and passenger vehicle steering applications. His publications have included a number of papers on transportation sensing in the fields of transmission, chassis level, steering, intelligent transportation and advanced driver assistance systems (ADAS). With a solid command of electro-mechanical assemblies and integration of electronics he has found a niche in the continued electrification of the power and drive train.

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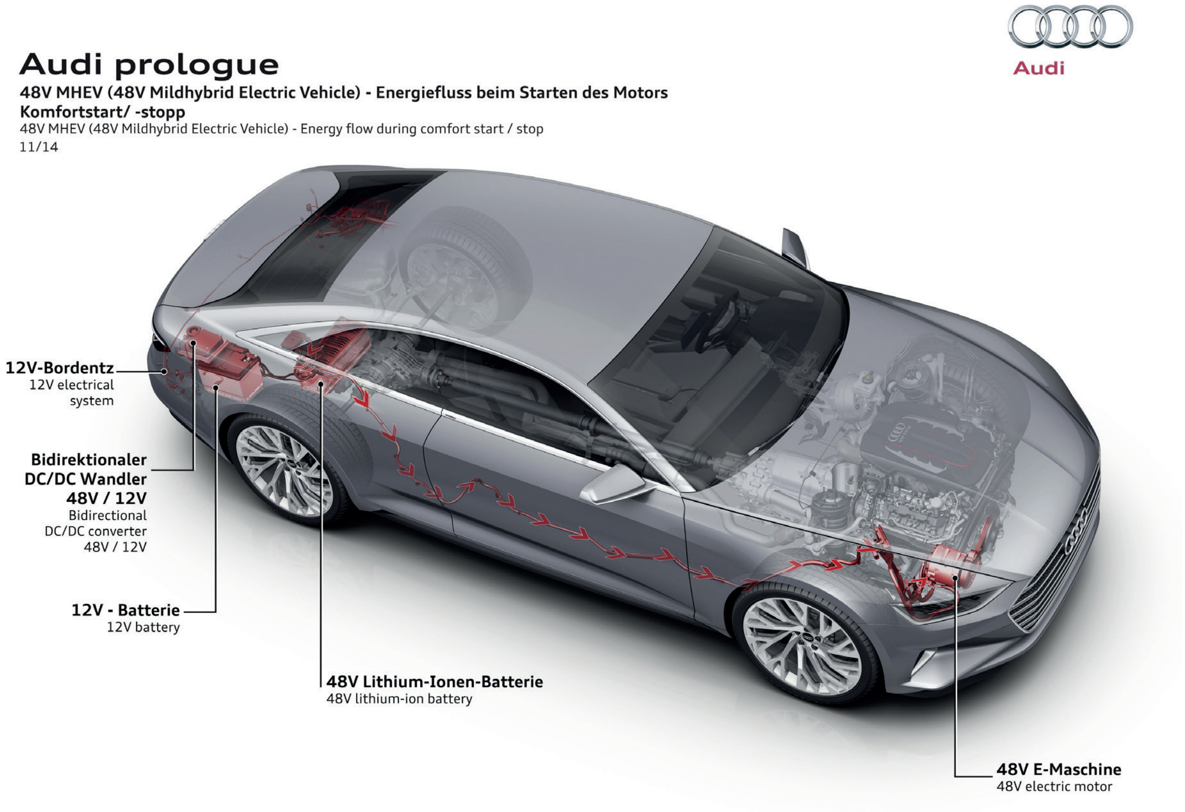

The Audi Prologue mild hybrid concept uses a 48-volt electrical network that supplements a conventional 12-volt system: here energy flow for comfort features is shown during idle-stop.

Source: Audi

2.3 Meeting future power requirements

A single, high-voltage 48-volt architecture is the most efficient method to meet future power requirements. The move to 48-volts has an order of magnitude comparable with the change from 6-volts to 12-volts in the 1950s. Issues relating to vehicle infrastructure, the state of component development, and the requirement for all devices to be redesigned to run off 48-volts, will mean a progressive move is necessary from a dual-voltage electrical architecture to a pure 48-volt system. A dual voltage approach provides the flexibility of accommodating both high- and low-voltage loads and smooth transition to 48-volts. There are still some engineers that question the validity of moving to a dual voltage power supply rather than switching directly to 48-volts. But it is hard to escape the thought that if it were so simple, we would probably have had 42-volt technology back in 1996.

The key problem with a single-volt architecture, assuming the feasibility of the technology, is the effort required to convert all systems on the vehicle to run on 48-volts. Independent of the engineering resource required would be massive investment in prototyping, homologation and testing. With typical system fitment today, without routine fitment of energy recuperating technology by example, the

7. Major factors delaying 48-volt roll-out

7.1 Introduction

In November 2015, at the 2nd International Conference Automotive 48V Power Supply Systems, held in Düsseldorf, Germany, Controlled Power Technologies (CPT), a major sponsor of the event, together with leading vehicle manufacturers and Tier 1 suppliers, argued the need for an internationally agreed 48-volt electrical standard. To date legislative standards have not been defined creating some uncertainty in terms of direction, implementation and specification. Whilst this may be a drawback for some participants, the German OEMs who are leading the charge on 48-volt have created their own LV148 standard.

7.2 Challenges and concerns – an overview

Contact erosion is a concern on 48-volt systems due to the high-voltages and necessitates that vehicle manufacturers must upgrade switches with more expensive metals and spring-loaded contacts that jump apart faster to reduce arcing. One could argue that we use higher 120- or 220-volt household switches running 10 to 20 times the voltage in a car, but the difference is the vehicle runs DC and not AC current. The voltage in alternating current wiring swings from 120 volts positive to zero and down to 120 volts negative and back 60 times per second in a sinusoidal wave. Any arcs produced dissipate as the voltage crosses zero 120 times per second, making for a clean break. DC current, on the other hand, remains at its rated voltage. One way to resolve this problem is to run with a dual architecture keeping switches, relays and sensors on a 12-volt network and reserving 48-volt for high voltage requirements only. In time components for direct 48-volt operation will be resolved. The other factor is of course the aftermarket, where the adaption to 48-volt could be even slower; hence maintaining a 12-volt system is a necessity in the near term.

The other impact on 48-volt technology is that innovations such as wire multiplexing and lead-carbon batteries have taken some of the need out of a higher-voltage architecture. One of the key systems understood to require a higher-voltage power supply was electrical power assisted steering (EPAS),

Figure 6 Ricardo HyBoost concept

Source: Ricardo

The HyBoost collaboration between JAC and Ricardo commenced mid-2014 and has already successfully passed its mule vehicle development gateway, a major decision event in a 48-volt project. The project team is now working to put into production the HyBoost concept for a JAC vehicle intended for launch in the Chinese market. This launch vehicle replaces the 2.0L MPFI engine with a downsized gasoline 1.5L TGDI unit and couples it with the 48-volt electrical system. The collaboration is also extending to the detailed development of control strategies and software as part of the necessary powertrain systems validation.

8.3 Bosch

Bosch is developing a 48-volt entry-level hybrid system that will be production-ready by 2017. Bosch says that the low-cost system, which enables stop-start functionality and braking energy recuperation, will deliver an approximate 15% improvement in fuel consumption, not only in controlled tests, but also in everyday driving situations. An electric boost feature also enables more dynamic acceleration; the motor generator provides the combustion engine with an additional 150Nm of support during acceleration. Unlike conventional 400-volt full hybrids, the 48-volt system can utilize less expensive components. Instead of using a large electric traction motor, Bosch enhanced the generator to output four times as much power. The motor generator uses a belt to support the combustion engine with up to 10kW. The power electronics form the link between the additional low-voltage battery and the motor generator. A DC/DC converter supplies the car's 12-volt on-board network from the 48-volt vehicle electrical system.

Bosch is now developing the second-generation of its 48-volt hybrid technology. In the prototype, the more powerful motor generator is connected directly with the powertrain rather than with the combustion engine. This allows the hybrid to provide all-electric driving even at low speeds, for example stop-start traffic,