48 V Technology in Production Cars

Electrification in the Aftermath of the Diesel Scandal

Automotive 48V Power Supply Systems

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The first series production cars to incorporate 48 V technology in one form or another have hit the road in recent times, and further integration of 48 V architecture is expected in the very near future. The Bentley Bentayga and the Audi SQ7 are the first two vehicles to incorporate a higher voltage electrical system, and the industry as a whole is gearing up for further development in the coming years.

Higher voltage systems are nothing new, of course, some 20 years ago 42V electrical systems were slated to be the next step in vehicle electronics. However, OEMs quickly discovered that high costs outweighed the benefits, and instead concentrated on better power management of 12 V systems. The increasing demand for power for performance-enhancing, self-driving, and safety technology requires new architecture, while regulatory demands to improve fuel economy and reduce emissions are also key issues.

As we know the CO2 emissions target for European manufacturers is 95 g/km by 2020, and one trend towards achieving that goal is to use 48 V systems within an existing powertrain framework to create 'mild hybrids' - conventional models with increased electrification for power hungry sub-systems such as turbo compressors and active suspension.

Having considered 60 V technology, the big five German carmakers - Audi, VW, BMW, Porsche and Daimler - agreed in 2011 to use a common framework for a 48V embedded power supply in future vehicles. Since then much progress has been made in what will be a major change in the automotive industry, and the technology is expected to become mainstream very quickly. So, how have these new vehicles implemented 48 V technology, and what developments can we expect to see beyond 2020?

Bentley Bentayga

Bentley was the first to market with a 48 V application, introducing its Dynamic Ride technology in the new Bentayga. The Bentayga is the British carmaker's first SUV and features an electrically actuated suspension system that responds faster than a conventional hydraulic system to cope with the demands of both on-road and off-road driving.

To manage the various demands of different driving surfaces, Bentley have split the Bentayga's anti-roll bars and fitted electric motors between the two halves. The system uses planetary gear sets to multiply torque, and can deliver up to 959 pound-feet of torque to each anti-roll bar. When driving on-road the system is most effective on corners, where the motors drive the anti-roll bars to press down on the outside wheels and lift the inside wheels to counteract body roll. When encountering bumps in the road and uneven surfaces, the motors produce upward force to lift the wheels, thus reducing the jolt transmitted to the body. Off-road, the system increases wheel articulation by decoupling the left and right wheels and using the motors to increase the compression or extension of the suspension.

According to Bentley, 48 V architecture was selected for the Dynamic Ride system because it allows more power and can much more quickly control the ride and roll characteristics. By constantly monitoring the steering angle, the position of each wheel and the lateral acceleration the motors can react in as little as 0.06 seconds.

The vehicle's main electrical system remains 12 V, while the componentry for the 48 V system is housed in the rear underneath the spare wheel. It consists of a DC/DC converter which steps up power from 12 V to 48 V, with the charge being held in a pair of super capacitors.

The actuators and the electrical systems add approximately 20kg to the weight of the Bentayga, but Bentley say this is a price worth paying for the increased performance. The difference may not be excessive in a large, heavy vehicle like the Bentayga, but it is much more of a consideration in smaller passenger cars.

Audi SQ7

Another member of the VW Group, Audi, has also recently introduced a vehicle with 48 V technology, and it goes a stage further than the Bentley system. The Audi SQ7 features a 48 V electrical sub-system which controls the electromechanical roll stabilization system (EAWS), and also powers an Electric Powered Compressor (EPC) to eliminate turbo lag as the first turbo spools up.

The similarities between the SQ7 and the Bentayga should be no surprise, since they are based on the same MLB platform, but Audi's use of an additional e-booster shows how 48 V technology can be utilized to dramatically improve performance.

The 48 V architecture is used to power the 7 kW electric compressor to fill in the torque gap at lower engine speeds. A 0.5 kWh lithium-ion battery is housed in the rear luggage compartment and delivers a peak power output of up to 13 kW. A DC/DC converter provides the connection the vehicle's main 12 V electrical system, which is supplied with 3 kW of power from an optimized alternator.

The power-hungry EPC provides the necessary boost in less than 250 milliseconds and spins at up to 70,000 rpm. This helps the SQ7's twin-charged V8 diesel engine produce 320 kW of power and 900 Nm of torque.

The 2.3 tonne SUV can travel from 0-100 kph in 4.8 seconds, and Audi has demonstrated its capabilities with marketing ploys such as a fake drag race with a fighter jet. The vehicle has been well received, and in May 2016 was rewarded as Autocar magazine's Innovator of the Year for its significant contribution to future car technology.

While the e-charger has been all about demonstrating increased power in this initial setting, it is expected to be used to help meet efficiency and emission quotas as targets become stricter. Audi says it can be used as a performance booster and an efficiency gain. Fuel efficiency can be improved by making the gear ratio longer, and in most cases, as Audi rolls out similar systems, there is expected to be a combination of performance boosting and efficiency gains.

Developing 48 V Technology

Both vehicles demonstrate the benefits of 48 V technology, but it really is just the starting point as far as the industry is concerned. Electronics supplier Delphi estimates that some 8 million vehicles with 48 V architecture will be produced worldwide in 2025, and it is emissions regulations that will lead the charge. 48 V powertrain systems are estimated to be able to provide 70% of a mild-hybrid's fuel economy at 30% of the cost to OEMs.

Earlier this year Delphi announced a 48 V vehicle solution, which was showcased in a Honda Civic 1.6 liter diesel car. The customized architecture maximizes the use of 48 V electrification to minimize demand on the engine, improving performance while lowering CO2 emissions by up to 10 %. Meanwhile, an e-charger increases low end torque by up to 25 %. Delphi has confirmed that it is working with two global automakers, and production could start as soon as within the next 18 months.

ADEPT

Another research project that is nearing completion is the Ricardo-led ADEPT program, which has applied advanced mild hybrid technologies with 48 V 'intelligent electrification' to a Ford Focus demonstrator.

The project partners include Ford Motor Company, the Advanced Lead Acid Battery Consortium (ALABC), Control Power Technologies (CPT), Faurecia Emissions Control Technologies UK, and the University of Nottingham. The final results of the project have been presented in September.

The aim of the project was to demonstrate an advanced 48 V mild hybrid powertrain architecture, capable of delivering near full hybrid-scale diesel fuel efficiency and reduced CO2 emissions. Key features of the vehicle include CPT's water-cooled SpeedStart switched reluctance belt starter generator (BSG), capable of delivering in excess of 12 kW of regenerative braking. Near instantaneous and near continuous torque assist levels of over 7 kW enable significant engine down-speeding, and highly capable start-stop functionality. Further recovery is achieved via CPT's exhaust-mounted 48 V turbine integrated exhaust gas energy recovery system, known as TIGERS.

The ADEPT powertrain includes a range of electrical ancillaries powered from the 48 V system rather than the engine, such as the vehicle air conditioning compressor. The 48 V architecture also provides significant levels of torque assist from the BSG to offset fueling to the engine for improved fuel efficiency, and to increase overall powertrain torque capability for enhanced vehicle performance.

Summary

In other news, Daimler has recently revealed that it will invest more than seven billion Euros in green technology in the next two years, including a 48 V on-board power supply system which will be introduced in 2017. Meanwhile, reports in the media suggest that VW is planning to release a stand alone electric vehicle based on 48 V architecture that will have a range of 186 miles. This may be part of the manufacturer's strategy to move towards electrification in the aftermath of the diesel scandal, and the VW Group already demonstrated its expertise through Audi and Bentley.

Europe is likely to lead the way in 48 V mild hybrids, as emission targets come into force by 2021, and the next few years promise a host of new concepts and ideas, as 48 V technology becomes mainstream in series production cars.

Sources

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