# The Development of a 48-Volt Power Supply

Brought to you by Automotive IQ

By Colin Pawsey

Back in 2011 the five premier German car manufacturers, Audi, BMW, Daimler, Porsche and Volkswagen, announced their agreement to jointly incorporate a variety of architectural components for on-board power networks into their vehicles. The five OEM's expressed their intention to implement a 48-volt power supply, and appealed to suppliers to actively engage in research and development of components for vehicles with a 48-volt electric system.

The concept of a higher voltage for E/E systems was under discussion as much as 15 years ago in regard to a 42-volt system, and although the idea was not taken further originally, the vehicle manufacturing landscape has changed significantly since then. When higher voltages were first being considered the driving factors were predominantly comfort functions within the vehicle, but today there is a more pressing need for electric vehicles, and a much broader base of powertrain and chassis functions which could also benefit from a 48-volt supply.

Despite the potential benefits, the 42-volt system was ultimately unsuccessful due to the high cost of components and the lack of a real driving force for development. In today's market components are much cheaper, technology has improved considerably, and the need to reduce $CO_2$ emissions is a substantial driver for the concept. The challenge for OEM's and suppliers is to create an inexpensive alternative to hybrid vehicles, which will provide a significant reduction in $CO_2$.

## Driving the change towards 48 volts

The European regulations for $CO_2$ emissions require automakers to achieve targets of 95g/km by 2020, and with further reductions on the horizon, 48-volt technology for the powertrain is a key issue. Stop-start technology, exhaust gas energy recovery and kinetic energy recovery can produce greater $CO_2$ reductions with a 48-

volt supply, and there are many other possibilities for improved fuel efficiency with a higher voltage supply.

Hybrid and electric vehicles cost OEM's a significant amount in development and production, and these costs are inevitably passed on to the consumer, with electric vehicles subsidised by governments to encourage $CO_2$ reduction. The challenge for OEM's is to create a fuel-efficient hybrid car, which is also affordable. The industry estimates that the additional cost to the consumer of implementing a 48-volt hybrid system to achieve a 30% reduction in $CO_2$ emissions could be as little as $1500 (£1000), for the equivalent performance of a typical 2-litre family saloon. This compares very favourably with the current UK subsidy of £5000 for plug-in vehicles, and the US subsidy of $7500 for electric vehicles.

**Increased potential**

The development of 48-volt systems is very much driven by the powertrain, and initial designs must overcome the problem of extra components, particularly when used alongside a standard 12-volt system. There will be a 48-volt battery, a 48-volt starter generator and an additional DC/DC converter, and it is important to understand how the 48-volt and 12-volt systems will interact with each other. A 48-volt supply, however, is below the 60-volt level which would require greater security, and offers potential benefits for other areas of the vehicle such as the chassis and interior.

Electric power assisted steering is reaching the limit of its capabilities in larger vehicles, and up to now it has not been possible to move away from hydraulic power assisted steering completely. This could be possible with a 48-volt electric system. More efficient PTC heating modules and more powerful electric fans could be used to prevent the interior from heating up, which would result in better exhaust gas quality as well as greater comfort for passengers. An electric-driven air conditioning compressor would also be able to maintain cool temperatures in the vehicle even when the engine is shut down due to the car being at a standstill. This could only be achieved through the higher operating voltage that a 48-volt system could supply.

**LC Super Hybrid**

Source: CPT/ALABC

The energy-efficient 48-volt LC Super Hybrid has been designed by The Advanced Lead-Acid Battery Consortium (ALABC) and Controlled Power Technologies (CPT), and a demonstration vehicle is being showcased in 2013, to follow up the 12-volt demonstrator unveiled at the Geneva Motor Show in 2012. The 48-volt vehicle offers additional functionality to assist with fuel economy and $CO_2$ reduction, including torque assist to the petrol engine for launch and low speed transient acceleration. Other features include optimised fuelling during idle and motorway cruise conditions with electric assist 'load point moving' and a leaner fuel calibration, in-gear coast down, and the ability to harvest more kinetic energy from regenerative braking.

The vehicle, which combines ALABC's advanced lead-carbon battery with CPT's SpeedStart motor-generator system, is based on a 1.4 litre VW Passat family saloon. The new generation of advanced lead-carbon batteries incorporate capacitive negative electrodes with added carbon, which are able to absorb high current pulses of brake energy and discharge high current pulses for frequent engine cranking and torque assist.

The technology was conceived by CPT and ALABC to show that significant reductions on $CO_2$ can be achieved through electric hybridisation at low voltages (12-48 volts), complemented by high power density advanced lead-carbon batteries. This

technology could offer manufacturers the potential to produce petrol-powered vehicles with impressive performance and fuel economy at a substantially lower cost than an equivalent diesel or high voltage (200-600 volts) hybrid.

**SK-Continental E-Motion**

Source: Continental. Gasoline engine will play an important role, given the high potential it offers for reducing fuel consumption and emissions, particularly through downsizing and turbocharging.48V Belt Starter Generator, Turbocharger, XL3.1. Solenoid Injector, Gasoline High-Pressure Pump GHP2, 48V DCDC, ECU14

Earlier this year Continental and SK Innovation launched SK Continental E-Motion to jointly develop, produce and distribute lithium-ion battery systems. The company has already started working on initial development programmes in the 48-volt mild hybrid sector, as well as the commercial vehicle sector.

The joint venture will offer a broad range of lithium-ion battery systems, from 48-volt to EV including HEV/PHEV and special applications for commercial vehicles, using both air-cooled and fluid-cooled technologies. Products will be based the complete cell line up developed by SK Innovation and the modular battery management systems provided by continental.

The company present four stages of electrification:

- The mild hybrid system which supports fuel saving in a combustion engine with start/stop while idle technology and regenerative braking and boosting, and offers up to 15% $CO_2$ reductions.

- The full hybrid system includes electric driving, allowing the motor and the engine to work in parallel, and offers a 10-30% $CO_2$ reduction potential.

- The plug-in electric vehicle can be charged for extended electric driving with the combustion engine taking over when the battery is empty, and offers a $CO_2$ reduction of 30-40%.

- The pure electric vehicle will replace the combustion engine with an electric motor and offer a potential $CO_2$ reduction of 100%.

**Johnson Controls Inc**


Source: Johnson Controls 48-volt Micro Hybrid Battery

Johnson Controls Inc is a leading supplier to the automotive industry, and earlier this year showcased a 48-volt lithium-ion micro hybrid battery demonstration module at the Hannover Messe. The battery will be used in conjunction with a 12-

volt starter battery and will enable greater energy and power efficiency while keeping overall system costs to a minimum.

The maximum power of the micro hybrid battery would be sufficient to power electric air-conditioning systems, active chassis control, storage and recuperation of brake energy, and to supply power to the drive system. According to Johnson Controls, the use of the 48-volt battery can also provide a 15-20% saving in fuel.

**Summary**

The regulations for the reduction of $CO_2$ emissions are getting ever tighter, and OEM's face a tough task to meet the targets. The need for an affordable, fuel efficient alternative to existing hybrid vehicles is pressing. 42-volt electric systems were discarded as uneconomical in the past, but today, there is a clear trend towards the introduction of 48-volt systems to achieve the necessary emission targets.

48-volt systems offer a variety of functions to assist with fuel saving, and the reduction of $CO_2$. Stop and start technology helps to save fuel while the vehicle is stationary, and torque assist can also be supplied to the engine for launch and low speed transient acceleration. Increased storage and regeneration of brake energy is also possible with 48-volt batteries, further improving on overall efficiency. In addition there are other possibilities with the use of a 48-volt supply that would not be viable with a 12-volt battery, such as fully electric power steering and electrically controlled air-conditioning compressors.

Since the five premier German OEMs announced their intention to integrate 48-volt technology there has been a concerted push by manufacturers and suppliers to develop the relevant components suitable for 48-volts. Initially the systems are likely to be implemented alongside a 12-volt battery to produce efficient hybrid vehicles while retaining the standard power supply, but in the near future we can expect vehicles to be fitted with just a single battery providing a 48-volt supply.

**Sources:**

http://www.cpowert.com/Energy-efficient-48-volt-LC-Super-Hybrid-makes-its-world-debut-at-Vienna

http://www.alabc.org/press-releases/ALABC_CPT_AABC_Strasbourg_PR_24_Jun_2013.pdf

http://www.cpowert.com/Exhaust-Gas-Regen-and-48-Volt-Cars-Next-Efficiency-Breakthrough

http://www.schlegelundpartner.com/en/48-volt-vehicle-electric-system

http://www.sk-continental.com/products.html

http://www.sk-continental.com/downloads/press/PR_20130121_SKI_Continental_Launch_FINAL_EN.pdf

http://www.johnsoncontrols.com/content/us/en/sustainability/for_our_customers/hybrid_batteries_at.html

**About the Author**

Colin Pawsey is a freelance technical journalist, focusing on new trends and technologies in the automotive sector. He is a regular contributor and writing consultant to Automotive IQ, and is also the founder of copywriting agency – Pure Copy.