



Combustion



Hybrid

48 V Hybrid Technologies – BorgWarner drives electrification in the automotive industry

Knowledge Library

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In order to make optimal use of the fuel efficiency and performance potential of 48V power supplies, BorgWarner is developing state-of-the-art technologies, expanding its portfolio with solutions for future mild hybrid vehicles.

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Hybrid vehicles bridge the gap towards electrification

The automotive market is changing towards electrification and demand for hybrid systems that are equipped with an electric motor and a combustion engine is growing. Automakers are adapting to these changes and rely on the experience and innovative solutions of suppliers. Utilizing its broad expertise as a global leader in clean and efficient technologies for combustion, hybrid and electric vehicles, BorgWarner provides state-of-the-art 48V technologies for hybrid vehicles and develops systems for the complete range of hybrid architectures.

Future-proof technologies for a changing market

Compared to conventional high-voltage systems, modern 48V power supplies provide numerous advantages. Crucially, they offer a high cost-effectiveness, as mild hybridization delivers up to 70% of the emissions and fuel efficiency benefits at only 30% of the cost of high-voltage hybridization. In addition, mild hybridization facilitates a rapid economy of scale, as automakers can use the same type of 48V motor/generator in a variety of applications and architectures. BorgWarner has developed various solutions for its customers to help them fully

utilize the advantages of modern power supplies. Several of the company's technologies, including the eBooster® electrically driven compressor, the 48V eFan and the innovative one-way clutch (OWC) for electrified drivetrains, are already available.

As an advanced turbocharging solution, the 48V eBooster system seen in Figure 1 operates independently of the exhaust stream, by driving the compressor turbine with an integrated electric motor. This allows it to provide outstanding torque in the low rev bands for virtually instantaneous acceleration without noticeable turbo lag while facilitating further downsizing and improving fuel efficiency by 5 to 10%. In addition, BorgWarner's innovative



Figure 1. BorgWarner's eBooster® electrically driven compressor uses the 48V power supply to improve engine performance while saving fuel.

system enables the use of larger conventional turbochargers for enhanced power and efficiency at high engine speeds. Fully leveraging the advantages of 48V systems, the eBooster technology thus improves performance and fuel efficiency significantly.

In order to deliver superior airflow and cooling performance for SUVs and commercial vehicles even under rough conditions, BorgWarner has developed the 48V eFan featuring a sophisticated electric motor and modular, lightweight package, see Figure 2. Due to its outstanding fan speed responsiveness, the innovative system works very quietly and offers precise temperature control. BorgWarner's eFan adjusts its performance on demand and immediately responds to the engine's cooling needs, saving energy and contributing to improved fuel efficiency.



Figure 2. BorgWarner's 48V eFan enables precise temperature control for improved efficiency and fuel economy.

Powertrain structures of hybrid vehicles are becoming increasingly complex. In order to adapt to these developments, transmission technologies need to evolve to allow optimal system integration. BorgWarner's advanced one-way clutch replaces the engine disconnect clutch and improves clutch control while delivering major packaging benefits. Furthermore, the technology supports the whole spectrum of hybrid drive functionalities such as electric driving,

boosting, load point shift, coasting, regenerative braking and recuperation.

Driving ahead hybridization

In order to be well prepared for future developments, BorgWarner constantly expands its 48V portfolio with new solutions. Currently, the company is working on technologies such as the electrically assisted turbocharger eTurbo™, the eTurbocompound generator and the Organic Rankine Cycle (ORC) system, that enable active energy recovery. While the eTurbo uses an integrated electric machine to either add power to the shaft for improved time-to-torque at low engine speeds or recover energy from the exhaust gas flow, both of the other technologies are concentrating on energy recovery. The eTurbocompound generator uses a turbine generator to enable cost-effective energy recovery with minimal effects on engine operation and vehicle packaging.

The Organic Rankine Cycle (ORC) waste heat recovery system shown in Figure 3, on the other hand, takes a purely thermal approach: it recovers heat energy from the vehicle's exhaust flow and sends it back to the vehicle via a heat engine. By using the regenerated energy to assist the vehicle's engine, the ORC system can thus contribute to improved fuel economy.



Figure 3. The Organic Rankine Cycle waste heat recovery system transforms heat from the exhaust gas flow into electrical energy to support the engine.

BorgWarner is currently cooperating with vehicle manufacturers to develop additional solutions for a broad range of 48V hybrid architectures. For example, the company is working on the iBAS (integrated Belt Alternator Starter), an alternator equipped with integrated power electronics. Stop/start systems such as this significantly reduce fuel consumption by switching off the engine once the vehicle stops. Accordingly, BorgWarner's iBAS facilitates fast and quiet engine startup while also offering high-efficiency energy generation, torque assist and regenerative braking.

In addition, the off-axis P2 module, which is expected to be launched in 2021, is more compact than conventional on-axis modules for P2-type hybrid architectures, since its chain-driven electric motor is positioned parallel to the transmission instead of in-between the engine and transmission. Moreover, it offers several hybrid functions including regenerative braking, boosting and pure electric driving.

Made for P3-type hybrid systems, BorgWarner's electric Rear Drive Module (eRDM), on the other hand, provides excellent driving characteristics by combining a full-function mechanical all-wheel drive with electric torque vectoring.

Finally, in order to combine the driving stability and traction of an all-wheel drive and hybrid functionality, the company is developing the 48V eAWD (electric All-Wheel Drive) technology as presented in Figure 4. The system slated for series production after 2020 drives the rear axle via an electric motor and a 2-speed transmission in a compact and highly robust package. Compared to conventional AWD solutions, the innovative system is nearly cost-neutral and has the potential to improve fuel economy by up to 9%.



Figure 4. BorgWarner's 48V eAWD combines electric hybrid functionality with all-wheel drive traction and stability.

BorgWarner has recognized the potential of 48V power supplies. Currently, the company is developing state-of-the-art technologies that take full advantage of these systems' benefits.

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