GKN Automotive Focuses on Powertrain Developments for EVs

Examines battery systems, vehicle range and charge speed

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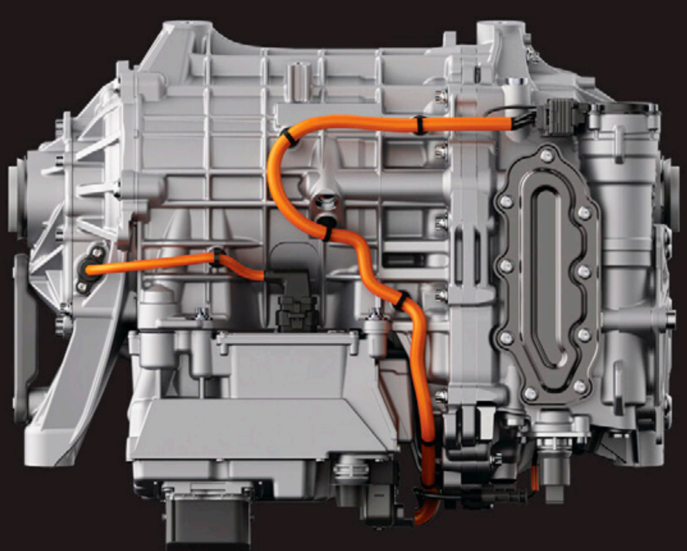


GKN's modular and scalable electric drive (eDrive) system can fulfil customer requirements for a wide range of vehicles.

As the world shifts towards sustainable energy solutions, the demand for electric vehicles (EVs) continues to increase, and at pace. This transition impacts the priorities of those throughout the industry—from OEMs to suppliers—as traditional automotive components are being replaced by electric motors, battery systems, power electronics, and thermal management systems.

For us, as a Tier One supplier, it comes down to making suitable choices. Across the range, we must prudently decide where to add value, which components to manufacture in-house or contract out, and which technologies we want to invest our knowledge and capital into.

At present, the three main areas of focus in the industry are: battery systems and optimizing range and charge speed; the charging system, both inside the vehicle and the charging infrastructure; and the motors and inverters within the driveline.

The question of efficiency feeds into every area of research and development within the EV industry. Efficiency is key to driving greater performance and enhanced sustainability. Put simply, the development and improvement of EVs comes down to its ability to efficiently convert battery energy into miles travelled.

Our key areas of focus are the efficient generation of torque using that energy and transferring that torque to the individual wheels.

Torque generation involves the transformation of energy in the battery into torque in the driveline system. For a battery EV, this consists of the inverter, motor and reducer which convert electrical energy into mechanical.

Inverters convert DC from the batteries into AC current for the motors. While this is a seemingly simple concept, the field of inverters demonstrates the speed at which the industry has needed to move forwards, as research finds new efficiencies and consumer demand evolves. The latest inverters offer a power output increase, as well as an increase in power density and power-to-weight ratio increases. These lead to faster charging times, decreased battery sizes, and improved performance.

More than 10 years ago, inverters typically offered around 110 V technology. Now, the most widely available technology is 400 V, with an increasing number of manufacturers looking to 800 V, and beyond.

As it stands, the adoption of 800 V systems looks to be slower than 400 V systems, due to the costs associated with the Silicon Carbide inverters used for an 800 V system. However, Gallium Nitride could follow Silicon Carbide into the power module market, which could drive down costs and increase capabilities.

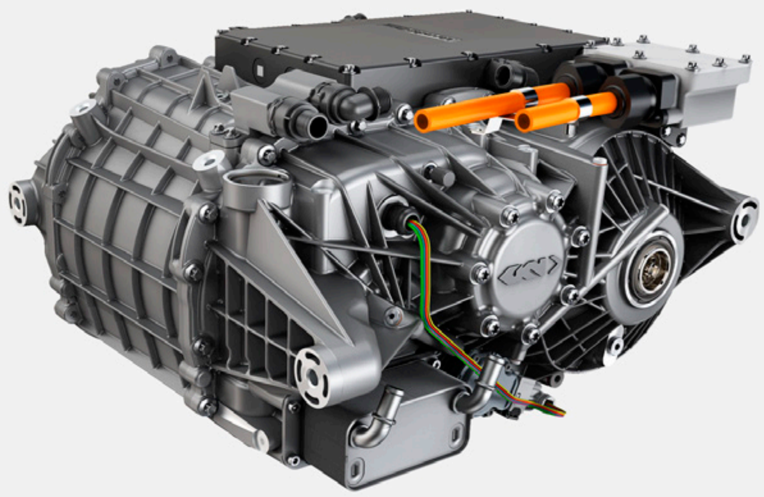
The opportunities and challenges of 800 V systems also impact motor technology. While the rotor design for the most part will be like a 400 V system, it requires—amongst other things—different insulation design on the stator as well as different terminal racks.

Within the torque generation system, the advancement of electric motors is pivotal in enhancing the driving experience, extending range, and accelerating the transition to sustainable transportation.

In recent years, significant progress has been made in EV motor technology, covering everything from efficiency to power density. Motor designs, such as permanent magnet synchronous motors have dominated, utilizing high-strength magnets and winding configurations to achieve higher torque output and efficiency.

Like internal combustion engines, electric motors generate a considerable amount of heat during operation. In EV motors, resistance encountered in the motor generates thermal energy, resulting in a loss of energy in the system through the dissipation of this heat.

To improve the efficiency, longevity, and performance of EV motors,



Efficiency and performance are essential for EV motors. Smaller, lighter packages that offer the same power output as larger units is necessary.

it is essential to reduce and manage these heat losses. As such, we have solutions for active oil-cooled motors that enable delivery of the same power output as larger units, but in a smaller, lighter, more affordable package.

By creating a modular and scalable electric drive (eDrive) system—consisting of the inverter, motor, and reducers (single- or dual-speed)—we can fulfil customer requirements for a wide range of vehicles. We can, for example, use three standardized motors to offer a power range of between 60 and 300 kW, depending on the customer's requirements.

Our second area of focus is around how the torque is managed from the drive unit, distributing it across the vehicle, from front to back, left and right, from axles to wheels.

Higher torques occur in an EV drivetrain because of the instant power availability. Open differentials and limited slip differentials help us to manage this torque and improve traction and control, depending on drive style and conditions.

The initial focus was on open differentials, then mechanical limited slip for enhanced torque transfer, then differential lockers for off-road trucks. We moved into more managed devices that include electronics and software, such as electronic limited slip differentials (eLSD) where the clutch manages each wheel's torque on one axle in a very detailed way, and eventually to twin-clutch all-drive devices for full independent torque transfer to each individual wheel on the axle. eLSDs not only improve the traction and stability of the vehicle, but also significantly improve its agility.

Our last area of focus is on transferring the torque to the wheels. In a standard internal combustion (ICE) vehicle, the power is typically distributed from the engine at the front, across the axle to the wheels.

However, in an EV, rear-wheel or all-wheel drive is favored, meaning that we need to look at the effect this has on drive components as the weight distribution shifts from the front axle to the center.

EV side shafts are significantly shorter than those in ICE vehicles, requiring different mounting points and larger installation angles. As a result, we are seeing increased plunge distances as well as changes to basic requirements for the constant velocity joints (CVJs).

These driveline components must withstand higher vehicle mass, greater acceleration torques, and up to 1,200 Nm of braking force to enable key technologies like regenerative braking. Despite their shorter length, EV side shafts must be stronger and more durable to withstand the vehicle's extra weight, while avoiding a significant increase in size to remain as efficient and cost-effective as possible.

Side shafts play a significant role in transferring torque efficiently from the axle to the wheel. As a rotating part, these parts are often a contributing factor to noise, vibration, and harshness (NVH) performance, to which EVs are particularly sensitive due to their low noise profile compared with ICE-powered vehicles.

It is vital that our product development is sustainable for years to come. As such, across the whole of the product development process, we are looking at developing alternative technologies. One example of this is the development of alternatives to rare earth magnets within the motors, to remove these materials altogether.

Other factors we must consider as we improve and enhance products are the reduction of copper in the motors and inverters, the origins and chemistry of the steels we use, and the lubrication oils and their source.

Not only that, but we must also consider our energy consumption as we produce the parts, ensuring we are continuing to sustainably manufacture driveline components that are fit for the future.

With forecasts indicating that future EVs will have a longer lifetime than today's ICE vehicles, improving durability is essential to the vehicle's longevity. This must be done without compromising efficiency, and crucially without adding even more weight. Therefore, a pragmatic approach favoring balanced system design with the lowest possible material consumption is vital to manufacturing in a way that supports a cleaner, more sustainable future.

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