Modular Electric Drive Unit

Highly integrative and flexible electric drive unit with up to three speeds

In future, all-electric drive systems with their local zero-emission status and potential independence from fossil fuels will provide a valuable and sustainable addition to the mobility landscape. Current electric-drive solutions normally consist of an electric machine combined with a fixed-ratio transmission and differential gear. Permitting a relatively low level of integration, their hill-climbing ability, accelerating performance and efficiency are limited too.

To provide high axle torque energy efficiently over a wide vehicle speed range without interrupting traction, the modular drive unit offers three gear ratios in a fully electric drive unit. As a further benefit, it can be integrated and scaled for application as an autonomous drive solution for electric vehicles as well as P4 hybrid applications. This makes the drive unit suitable for different alternative drive configurations, such as axle-hybrid, range-extender, battery-powered or fuel-cell vehicle in a variety of vehicle segments.

Nemak as Casting Technology Development Partner

In cooperation with Nemak, the globally operating manufacturer of aluminum castings for the automotive industry, our experts have analyzed the specific demands on the e-motor and optimized the design of the housing. Besides casting components for the combustion engine, Nemak's product portfolio also covers the production of structural components as well as casting components for electric mobility.

IAV has engineered the modular electric drive unit for the latest generation of all-electric drive units. The three-speed power-shift transmission makes optimum use of high-efficiency engine operating ranges, improving drivability and cutting energy consumption.
Saving in three gears

The aim in developing the IAV modular electric drive unit is to produce a drive solution that takes account of the different demands on hill-climbing ability, accelerating performance, efficiency and top vehicle speed.

Electric drive systems with a fixed gear ratio fall short of the optimum in meeting all of the operating requirements for the vehicle concerned – in particular, the transmission ratios demanded vary widely for hill-climbing ability and efficiency. This is why IAV has designed this unit as a three-speed power-shift solution.

An induction machine is used with a continuous output of 50 kW and a maximum output of 80 kW. Continuous torque is 150 Nm, maximum torque 300 Nm. Compared with a permanent-magnet synchronous motor, benefits are produced in terms of robustness and shut-off in the event of a fault as it can simply be deactivated by switching off the inverter. The 3-speed transmission in planetary gear-train design positioned to the side of the e-machine provides the capability of producing axle torque in excess of 3,000 Nm. At the same time, the demand on maximum e-machine speed is limited to just 8,000 rpm.

With the differential being accommodated inside the e-motor, optimum use is made of available package. The overall transmission ratio is adjusted by the spur gear stages that are mounted downstream of the differential and are easy to adapt to the specific application case.

Against a pure coaxial solution, this produces package benefits as the output axis can be spun in relation to the unit’s actual centerline, making it much easier to observe the ground clearance limit or meet other package restrictions. On demand, the hydraulic module with integrated electric oil pump provides the pressure and volumetric flow required for the circuits that split off downstream of the main control valve for lubrication, cooling as well as actuation.

The IAV modular electric drive unit can be used in segments A (microcar), B (subcompact car) and C (compact category), either as an all-electric drive unit in battery-powered, fuel-cell or range-extender hybrid vehicles or as an additional drive for P4 axle hybrid arrangements.

A high level of functional integration and tight package constraints demand excellent housing development. Working together with Nemak, the specific e-motor requirements were analyzed and the housing design was optimized in terms of functional integration, cooling, structural stiffness and NVH as well as cost-effective, large-scale and robust manufacturability. Nemak manufactures e-motor housing using the three casting technologies of high pressure die-casting (HPDC), low pressure-die casting (LPDC) and core package system (CPS®). In view of a growing geometric complexity, the low-pressure die-casting and the core package sand process are moving more and more into the focus.