Future electric mobility with CAN in-wheel system

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The playing field of the automotive industry has significantly changed with the arrival of electric vehicles to the mainstream market. Today, electric vehicle design and production is not limited to only traditional players, but has become an open playing field for anyone with resources.There is a vast number of competing powertrain architectures and technologies - some simple adaptations of the traditional 100-year-old ICE concept, and others more advanced, which bring more radical changes to a car.

Since a lot of different technologies are possible and viable, and development of mass-production compatible electric powertrains is practically in its infancy, vehicle makers are scrambling to find the right formula for the future consumer demands.

Currently, electric vehicles are competing on acceleration performance and range, but in the future, the discussion will be less about cars and more about mobility, of which electric vehicles will be one of the main pillars. Vehicle makers are increasingly focusing on electric vehicles with autonomous driving functionalities and connectivity. The defining characteristic is that the new vehicles are not designed for the driver, but rather the user. The "form factor" is a rolling chassis with space allocated above the wheel for people and goods utility of mobility. It means that the powertrain will be much less in the spotlight; Instead, function, safety, and comfort, with high-level of autonomy and connectivity will become the main drivers for consumers.

There is a requirement for an efficient development process, which means effective and less time-consuming packaging of powertrain components, increased control of the vehicle and of course, more and more focus on software and related safety functions. Because of the many new possibilities and design freedoms they offer, (inwheel) wheel hub motors are a new favorite of the designers as the basic e-powertrain technology. Since the end of the 1980's, the development of such technology for the European automotive industry has been the main focus of Elaphe Propulsion Technologies specialists. With many successful past and ongoing projects, and planned developments, the industrialized in-wheel technology is finally being commercialized as the ultimate powertrain platform for the next generation of autonomous and connected electric vehicles.

From a future market standpoint, the powertrain will need to become invisible to the user as much as possible, and the software will likely be the main differentiator.

Figure 1: The automotive-grade ASIL-D-rated PCU 2.0 enables use of four separate CAN networks and supports Flexray; As an ECU, it is compatible for use on many different levels of control within a vehicle – including serving as a powertrain controller for autonomous applications built on top of the stack (Source: Elaphe)

The depth of impact for software will greatly depend on the basic possibilities that the powertrain offers to exploit (functionality, power electronics, space, controllability, etc.). This is where in-wheel powertrains provide enormous value and possibilities. The business model for use of vehicles will change, so considering the vehicle as a smart device, which can add functionalities and features as if adding apps on your phone, is a likely analogy.

One other thing is that the vehicles will begin to change exterior and interior form with increasing autonomy and different propulsion architectures. In line with the packaging requirements, the motors will likely need to take less and less space to enable low and flat floors, maximizing spaciousness inside a vehicle while still keeping a minimal outside size footprint. Another benefit will also be the increased battery capacity, which will still play a major role, but will come from three different facts - there will be more space available on a vehicle for a larger battery due to novel architectures; the vehicles will feature reduced powertrain weight and increased efficiency; and we will have access to increased battery energy density that evolves with time.

In-wheel technology thus plays a significant role in the development of compact, transmission-free drive systems. Increased safety, improved handling, and unparalleled traction control are just some of the benefits of the decentralized in-wheel architecture. Having a lower powertrain ▷

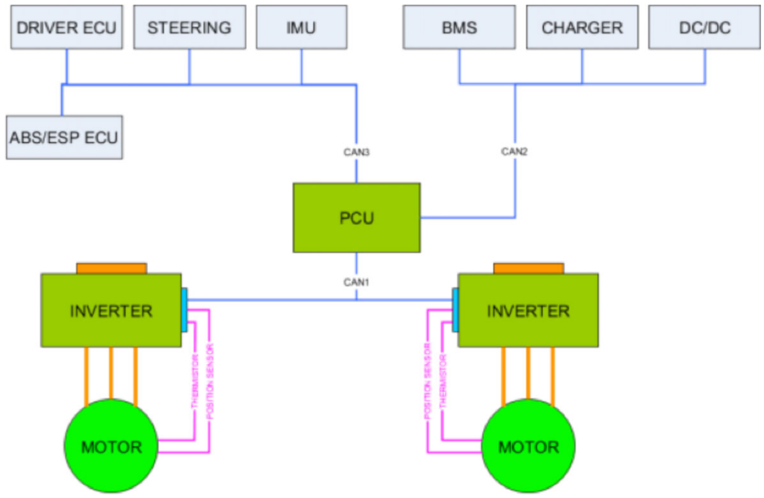

Figure 2: Conceptual schematic of separate CAN communication networks within a distributed powertrain system (Source: Elaphe)

weight, a lower vehicle center of mass and optimized balance, the dynamic behavior of the vehicle changes dramatically. The drive architecture with its weight distribution and contact pressure at precisely the point of traction allow greater control over the vehicle's behavior in comparison to standard drives. More so when you consider the possibilities of advanced systems such as brake blending. This greatly shortens emergency braking distances on lowadhesion surfaces, active traction control that is constantly optimizing the grip between the wheel and the road, and torque vectoring, improving vehicle stability and keeping control over vehicle dynamic behavior in unstable, critical situations.

Elaphe recently launched the newest version of its L1500 motor, currently the highest-performance passenger car in-wheel motor in production. It generates more than 1500 Nm of torque and featuring the highest torque density of a direct-drive in-wheel motor in the world. The motor is designed for upper segment passenger cars, such as SUVs, large sedans, light delivery vehicles, and other electric vehicles in the given weight and performance class. The L1500 in-wheel motor features one of the most compact and torque-dense e-machines in the world. The unit is lightweight (less than 31 kg added weight) and the compact active part allows standard wheel bearings and disc brakes to be integrated within the e-machine envelope. The L1500 fits into a 19-inch or larger rims and is able to produce up to 110 kW of mechanical power in each driven wheel.

One of the key novelties of the in-wheel powertrain architecture is that it enables individual control of each wheel. While it comes as a benefit for vehicle control and behavior, it also requires an intelligent system to wholly control the vehicle propulsion system, and optimize the overall driving performance with advanced functionalities. The brain of the Elaphe in-wheel powertrain platform is the PCU – the propulsion control unit. It is the home for powertrain control and advanced features such as traction control, torque vectoring, brake blending, battery power control, data logging and drive analytics. Support for various driving modes is developed and optimized for the system.

The vehicle control unit is based on ASIL-D-rated hardware architecture with a tri-core redundancy-enabled micro-processor and a watchdog monitored power supply. The PCU has four CAN interfaces. Each of the CAN interfaces can be configured to run at a bit rate from 125 kbit/s to 1000 kbit/s. The use of a standard or an extended CAN frame is possible. One of the CAN interfaces is compatible with the CAN Flexray interface, with data transmission rates ranging from 1 Mbit/s to 10 Mbit/s. One of the PCU's main tasks is responsive communication with the main powertrain and chassis ECUs and components, such as the BMS, charger and DC-DC. The individual motor-controllers are isolated on their own separate CAN network, driven by the PCU. The CAN transceiver controls the functions as displayed on the figure below:

Interfaces include all hardware and software safety mechanisms with features such as CAN-H or CAN-L short to Vcc or GND, over temperature protection, Bus Dominant Clamping, TxD to RxD Short Circuit Feature, RxD Permanent Recessive Clamping, and Remote wake-up via a message on the CAN network, paired with high ESD robustness. The Flexray transceiver features bus failure protection and error detection in the over-temperature protection mechanism.

The PCU also enables secure communication to an infotainment system through an integrated Bluetooth 4.2 interface using the company's eDash application to provide basic drive-mode settings, drive-data and diagnostics during development phases of a vehicle. The PCU module is fully compliant with ECE R10 R5, ISO 7637-2 (2004) in ISO 16750-3 standards for automotive applications. It features a high voltage interlock loop (HVIL) input, and requires safety features, such as sensor supply short protection and reverse polarity supply protection.

Elaphe is dedicated to developing the full system to truly provide a full, industrialized powertrain platform as the answer to the needs of electric vehicle manufacturers and designers today, making it the ideal platform for lightweight, efficient, and modular all-vehicle designs. The company works successfully with many vehicle manufacturers to realize the benefits of in-wheel architecture in new platforms and offers its partners the opportunity to extend their technological advantage. ◀


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