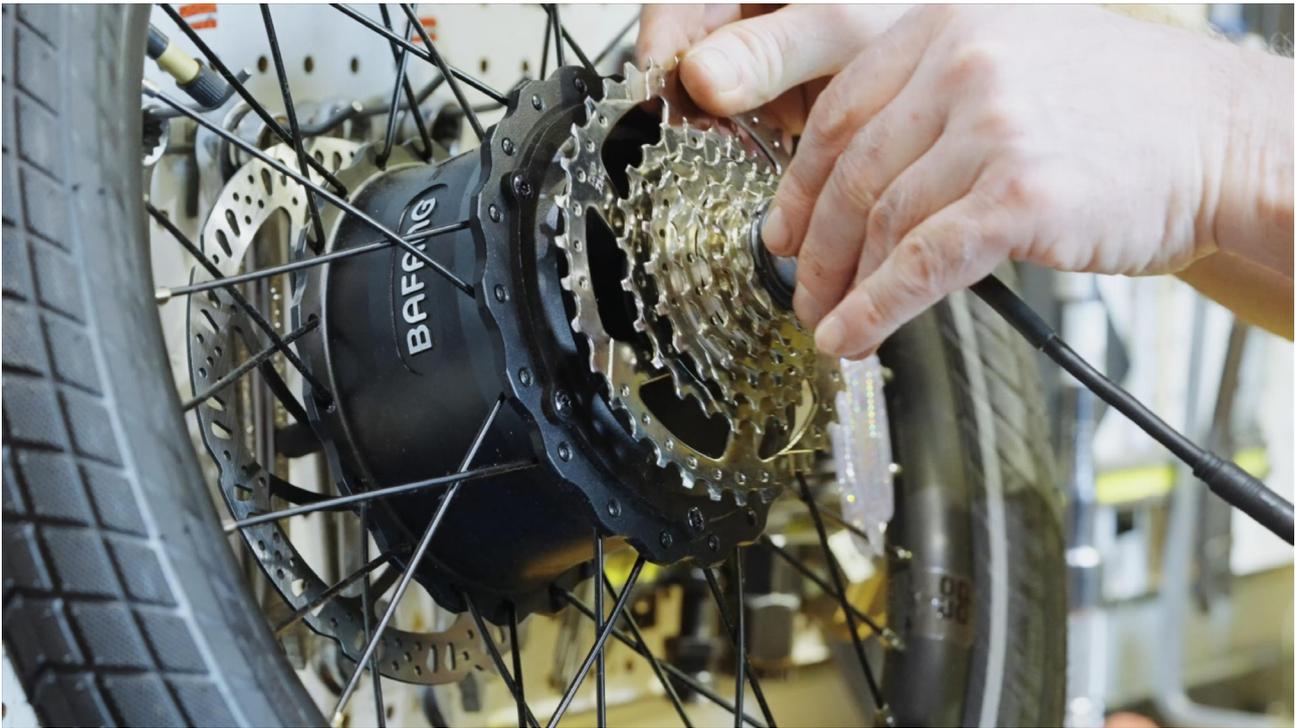


## Light electric vehicles use increasingly embedded CAN networks

*Since more than ten years, pedelecs, e-bikes, and other light electric vehicles (LEV) are equipped with embedded electronic communication systems. They connect electric motors, batteries and chargers as well as sensors, displays, and host controllers. Increasingly, they are based on the CAN CC (classic) protocol.*



*Figure 1: Many of LEV drive units provide a CAN-based interface to communicate with batteries, HMs, and EMS (energy management system) host controllers, but the higher-layer protocol is mainly proprietary (Source: Bafang)*

The market for electric-powered bicycles is huge. In 2021, there were sold about 41 million e-bikes in China. Of course, not all of them comprise embedded CAN networks. However, most of the European pedelecs use embedded CAN networks. Have in mind that some people talk about e-bikes, while they are meaning pedelecs. According to European regulations e-bikes are not pedelecs, which need pedal assistance. E-bikes are two-wheelers with an electric motor, which do not require pedaling. In many countries, you need for e-bikes a driver license, which is not required for pedelecs.

Most of the embedded CAN networks use proprietary higher-layer protocols. Although, the nonprofit Energybus and CiA organizations have developed based on CANopen CC (classic) some specifications for energy management (CiA 454 series), the Tier-1 suppliers implement proprietary CAN-based higher-layer protocols. The standardized CANopen CC approach is already partly internationally standardized in IEC 61851-3-4 and IEC 61851-3-5. These two Technical Specifications describe a CANopen-based

communication interface between the battery of a light electric vehicle (LEV, including pedelecs) and a charging station. This enables a manufacturer-independent charging of pedelecs and e-bikes. This is important for public LEV charging, especially in cities and tourist regions. The IEC 61851-3-4 document specifies the basics including the physical layer (cabling and connectors). IEC 61851-3-5 provides the charging data details to be exchanged between charger and battery. The CiA 454 profile specifies additional interfaces for LEV equipment (e.g. drive unit) and can also be applied to other energy management applications.

In the last years, the market for CAN-connectable LEV electrical drives saw an increasing number of suppliers. Besides Bafang, there are Bosch from Germany and Shimano from Japan as well as many others including Brose (Germany), SEG (Germany), Yadea (China), and Yamaha (Japan) in alphabetic order – just to name a few. Bosch and other leading drive suppliers offer a range of products dedicated for special LEV applications ranging >



Figure 2: Typical 600-W mid-drive weighing less than 2,6 kg and powered by a 36-V battery (Source: SEG)

from generic drives to those dedicated for mountain, racing, or cargo pedelecs and e-bikes. Some of them can be connected to ABS (anti-lock braking system) units. Some others – like the ones from Shimano – support optionally an automatic and free-shift gearing.

Brose, a German Tier-1 supplier for the automotive industry, starts volume production of its Drive3 Peak

drive unit in this year. At its peak, the 48-V pedelec drive platform provides 410-percent assistance at a maximum speed of up to 25 km/h according to the company. Of course, the company supplies also related removable batteries (up to 814 Wh) in aluminum housings and displays for all drive types. “Our complete system offers optimum interaction between Brose drive, control unit, and battery. It is optimized for even better integration and combination of system components such as drive unit, HMI, and battery. This coordination of the components with each other refines the overall Brose driving experience. At the same time, you also benefit from service from a single source,” states the company on its website. This unburdens the pedelec OEMs (original equipment manufacturers) from unit integration challenges, but makes them depending on a single source. Other Tier-1 suppliers also offer turnkey solutions providing a complete LEV electric control system comprising drive units, batteries, and human machine interfaces. Of course, an embedded proprietary CAN communication is the base for these products.

As the LEV industry faced a challenging year in 2023 due to a slowdown in demand caused by an unstable

international climate and high inventory levels, Bafang, an LEV drive system supplier with over 20 years of experience in the two-wheeler industry, proactively adjusted its pace to meet market changes. In 2023, the Chinese company headquartered in Suzhou celebrated several milestone moments including its first dealer conference. Facing industry challenges ahead, the company will provide more comprehensive support and protection to each customer by improving production automation coverage and expanding the global after-sales service layout.

### Hidden champions and carmakers access the LEV markets

SEG Automotive is a hidden champion of the automotive industry, powering over 300 million vehicles on the road today with their e-machines. Now, the German company is entering the market for electric bicycle motors as a partner of BH Bikes, a Spanish OEM. It is a mid-engine for pedelecs. Weighing in at less than 2,6 kg and equipped with a 36-V battery, the engine sports a peak power of 600 W and up to 400-percent maximum support. “Like us, SEG Automotive has a history of performance, reliability, and competitiveness dating back over 100 years,” stated BH Bikes. “Having such a strong partner close to us, with this level of experience in highly efficient electric motors, gives us the opportunity to continue riding at the front of the e-bike movement.” The drive units have been designed and developed in SEG Automotive’s plant in Cantabria, Treto – and they will also be produced in this location, which itself has a history of producing electric motors dating back more than 60 years.

Inaki Calvo, Treto Plant Manager, mentions that they have added key competencies in electronics, hardware and software, which allows them to bring to the market ▶



Figure 3: Automakers offer high-end pedelecs sometimes in the same color as the car (Source: Porsche)

new solutions for sustainable mobility. "In fact, we are already developing a further evolution of this e-bike drive that is even more compact and efficient – and will bring this solution also to other markets in, and beyond, Europe." The four-year contract with BH marks SEG Automotive's entry into the LEV market. "SEG Automotive has the know-how, the track record, and the technology to power all kinds of vehicles, and we have been expanding our product portfolio to enable existing and new ways of sustainable mobility," explained Ferdinando Sorrentino, CEO of the German-based company. In addition to e-drives for cars and commercial vehicles, this also includes dedicated solutions for LEV mobility. On the market, there are already an engine and electric controllers for e-motorbikes, as well as a range of e-motors specifically for the Asian market to power various electric two- and three-wheelers.

Yadea, a Chinese brand, has shown on the Eurobike 2023 tradeshow its Trooper 01 motorcycle-style design with the convenience and accessibility of an electric-powered bike. "Riders can now experience the freedom and excitement of cruising through scenic landscapes and bustling city streets, all without the need for motorcycle-related licenses or regulations," stated the company. The Trooper 01 is equipped with a 750-W motor. Its 20-inch by 4-inch tires and embedded CAN network provide enhanced stability and maintainability, ensuring a smooth and enjoyable riding experience on various terrains, informed Yadea.

It is not only the traditional bike industry and automotive Tier-1s, which are interested in the growing LEV markets. The automotive OEMs also start to get a slice of this pie. According to a study by PWC, a British market research service provider, vehicle ownership in Germany will fall by 25 % in the next five years. As more and more people see how pedelecs can replace a car for the majority of journeys, it's inevitable that car sales will suffer, predicts the study. Consequently, the car industry is realigning itself as a 'mobility' industry. In 2021, Germany's largest automobile show was rebranded as a 'mobility' show, and car manufacturers are turning their attention to LEVs and micro-mobility. VW, Audi, Mercedes, and Porsche are among a growing number of car brands that have begun producing electric-powered bikes in recent years.

Last spring, Porsche has introduced two pedelecs, the eBike Cross Performance and the eBike Cross Performance EXC. They are equipped with the Shimano EP-801 motor and a 630-Wh battery. Both uphill and downhill, the electric 12-speed Shimano rear derailleur delivers the right gear. The CAN-connectable EP801 motor offers two riding profiles: Profile 1 offers the three support modes Eco, Trail, and Boost, while in the Fine Tune Mode of Profile 2 up to 15 support parameters can be individually set.



Figure 4: Anti-tampering logo by the nonprofit Confederation of the European Bicycle Industry (Source: CONEBI)

## Fight against LEV tampering

Shimano offering the EP801 drive unit for battery-powered mountain bikes (MTB) has recently announced to fight against any kind of manipulation of LEVs, especially drive systems, e.g., to increase the performance or the maximum supported speed. "Riding manipulated e-bikes on public roads may not only lead to technical problems but also result in serious legal consequences," explained the Japanese company. Tampering kits and other types of manipulation can damage the drive system as well as the bike itself. Riders would risk losing their guarantee and invalidating their warranty claims. If an accident occurs with a tampered LEV, it may result in criminal prosecution. Shimano supports the self-commitment of CONEBI, the Confederation of the European Bicycle Industry, to prevent the tampering of LEVs. There are 15 national bicycle industry associations and 68 companies, which have signed this self-commitment from 2021.

Erhard Buechel, President of CONEBI, said: "The bicycle industry takes the topic of tampering very seriously and has started several actions to curb this dangerous practice. This self-commitment is only one pillar of our overall strategy. Moreover, market surveillance must be strengthened at national level supported by European legislations. Last but not least, we condemn very strongly the sales of tampering kits, which endanger the safety of consumers as the e-bike is not designed for such an increased speed. We therefore call upon the European legislators to clearly forbid the sale, application, and use of tampering equipment."

Shimano ensures that all anti-tampering requirements, which are included in EN 15194:2017, are met. It continuously evaluates the existing standards to see if they are still fit for purpose when it comes to anti-tampering measures. Of course, the company is working on improving its drive systems to make tampering more difficult. The CiA 454 profile specification series is not yet providing anti-tampering measures on CANopen interfaces, but CiA is working on a standardized secure CANopen solution. Unauthorized access to tamper the drive unit could be avoided with this approach. ◀

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