The Royal League in ventilation, control and drive technology

ZYwheel

Efficient, silent, eco-friendly –
The gearless electrical in wheel hub drive for city buses, airport buses, municipal commercial vehicles and underground mining

ZIEHL-ABEGG
People from around the world come into contact with products from ZIEHL-ABEGG every day. Elevators are powered by ZIEHL-ABEGG motors, subways are ventilated with ZIEHL-ABEGG fans and hybrid buses drive with generators from ZIEHL-ABEGG. Innovative ventilation technology, drive technology and control technology from ZIEHL-ABEGG are found in industrial plants, in wind power and other power stations, in large buildings such as the Allianz-Arena, in hospitals, in trains and in many other applications. ZIEHL-ABEGG is certified in accordance with DIN 9001 and 14001. The family-managed company is the world’s largest supplier of motors and electronics for SMB elevator manufacturers and is also the technology leader for large, industrial fans.

At the headquarters in Künzelsau, 300 technicians and engineers are working on innovations for the drive technology, ventilation technology and control technology of tomorrow. More than 3400 employees currently work in the global nine production facilities, seven assembly sites, 27 subsidiaries and 87 sales offices. That all started more than one hundred years ago with the development and construction of electric motors. That expertise has been flowing into the Automotive Division since 2004. To do justice to the significance of e-mobility, in late 2011 ZIEHL-ABEGG founded the company ZIEHL-ABEGG Automotive, which has its head office in Kupferzell. ZIEHL-ABEGG is focussing its core competencies in the area of in wheel hub drives, axle drives and generators to provide the commercial vehicle industry with advanced solutions.

Welcome to the best.
Welcome to the Royal League.
**ZAwheel benefits the citizens, the environment and the operating organisations**

Silent, efficient, eco-friendly: The in wheel hub drive

For the trend-setting concept of the electric in wheel hub drive, ZIEHL-ABEGG is taking advantage of its experience as the technology leader in the development of electric motors – aimed at maximum performance with minimum energy consumption – and is accomplishing exactly that in the tightest possible space.

The benefits of having the drive directly in the wheel are convincing: The torque is exactly where the power is needed. Power-consuming transmissions and differentials can be omitted. On top of that, the ZAwheel converts the braking energy directly back into electricity. The result is top efficiency and environmental friendliness.

**ZAwheel in wheel hub drive**

+ Can be used for new vehicles and for retrofitting
+ Improved driving comfort
+ More space for the vehicle design
+ Resource conservation
+ Elimination of approx. 80% of the moving parts in the drive train making it:
  + low maintenance
  + easy to maintain
  + eco-friendly
  + produce minimum noise characteristics (< 70 dBA at 80 km/h)
+ Highest drive efficiency of approximately 90% (battery to wheel)
+ Regenerative operation (recuperative)
+ Minimum energy consumption: approx. 0,8 kWh/km
An overview of the ZAwheel system structure

The axle drive module from ZIEHL-ABEGG Automotive was specifically developed for use as an electrically driven low-floor axle and can be used in solo buses as a rear-axle drive as well as in articulated buses as a rear-axle drive and/or mid-axle drive. Conceptionally, the low-floor system can be utilised for serial hybrid buses as well as for all-electric city buses and is deployed for city buses with maximum axle loads of up to 13,000 kg. Eliminating about 80% of the moving parts in the drive train makes ZAwheel the leader in:

- Total efficiency (battery to wheel)
- Noise characteristics
- Maintenance expenditures
The systems components in detail

The drive concept: A gearless single-wheel drive using a liquid-cooled permanent-magnet energized synchronous motor (PMSM) with integrated power electronics. The combination of two driven axles and single-wheel drive produces advantages for both the tyre wear as well as for the traction. The axle drive module comprises the low-floor frame, in wheel hub drives with integrated power electronics and the rims, brakes, brake disks, and sensors for temperature, ABS, motor speed and tachometer. That adds up to a maximum drive power of 364 kW per axle and provides a continuous output of 226 kW with a total efficiency of 90% (battery to wheel). Along with the in wheel hub drives driving the wheels, they can also be used as generators for regenerative braking (recuperation).

The installation space and the fitting dimensions are compatible with common standard portal axles for low-floor buses, which spares having to make elaborate adaptations on the bus undercarriage. In addition, the vehicle manufacturer gains more flexibility when designing the bus. That all results in potential improvements on the vehicle, such as a wider tyre track, wider spring spacing and a wider middle aisle of up to 880 mm for the low-floor bus.

The concept of this electrically driven low-floor bus in inner-city traffic with many stops and go’s provides especially cost effective and eco-friendly deployment.

Axle drive module
1 ZAwheel with integrated power electronics
2 Rim
3 Shock absorber
4 Chassis beam and cross beam for axle guidance
5 Low-floor frame and brake disks
6 Air suspension
7 Support arms for air suspension
8 Brake cylinder

The super-wide tyres improve the handling, produce less rolling resistance and provide more space for the vehicle design.

Drive module
Vehicle type: City bus, airport bus
Application: Solo/articulated bus
Design: Low-floor bus
Drive: Independent direct drive, gearless
Axle load: 13,000 kg
Axle weight: 384 kg (without attachments)
Sensors: ABS, tachometer
Rim size: 22.5" x 15"
Tyre size: Super-wide tyres 455/45R22.5
Efficiency: Approximately 90% (battery to wheel)

In wheel hub drive ZAwheel SM530
Voltage range: 400 - 700 VDC
Nominal voltage: 600 VDC
Rated current: 200 A
Rated power: 113 kW
Rated torque: 2700 Nm
Speed range: 0 ... 485 rpm
Max efficiency: Approx. 92%
Sensors: Temperature, speed
Type of cooling: Water cooled
Electronics: Integrated power electronics
Impressive proof

Nowadays environmentally-friendly mobility is a must. With the silent ZAwheel in wheel hub drive, ZIEHL-ABEGG Automotive offers not only an environmentally friendly and extraordinarily innovative drive, but is also performing pioneering work in the field of electric mobility – always with the ambition of providing the highest quality, which has been recognized in the field of electrical drives for over 100 years. So ZIEHL-ABEGG is more than delighted when recognized experts and institutions take notice of and award this innovation and quality.

Environmental Technology Award 2013
The Ministry for Environment, climate and Energy of Baden-Württemberg has honoured ZIEHL-ABEGG for the ZAwheel electric in wheel hub drive with the environmental Technology Award 2013 in the Emissions Category.

Plus X Award
The innovative ZAwheel in wheel hub drive from ZIEHL-ABEGG received several seals of approval from the Plus X Award – the symbol for brand quality: The recognized and independent award jury comprised of more than 130 industry-neutral jurors from 32 countries, all of them well-known technical journalists and industry personalities. ZAwheel was honoured with the „Best Product of the Year“ in the category of electric drives plus the seals „Innovation, High Quality and Ecology“.

German Stevie Awards
In 2015 ZIEHL-ABEGG received several German Stevie business awards. A jury of 50 awarded the ZAwheel with a gold Stevie for its maximum performance while reducing energy consumption, traffic noise and pollutant emissions.

National Environmental Prize Energy Globe Award
ZIEHL-ABEGG Automotive has been honoured for the ZAwheel with an Energy Globe Award in the Netherlands. The jury, chaired by Maneka Gandhi, issued this substantiation for awarding the National Environment Prize: „The electric drive from ZIEHL-ABEGG for commercial vehicles such as buses or waste vehicles reduces both noise and pollutants almost entirely“.

German Federal Ecodesign Award
The Federal Environment Ministry/ Federal Ministry for Environment and the Federal Environment Agency honoured ZIEHL-ABEGG with the prestigious Ecodesign Award for the ZAwheel in wheel hub drive.
The deployment of ZA wheel has many opportunities

Solo buses

Articulated buses

Airport buses

Double-decker buses

Waste collection vehicles

Special vehicles in underground mining
The comparison demonstrates: ZAwheel is the eco-friendly future

Minimising the energy-demand and maximising the efficiency

Conventional systems, such as central-motor and electric portal axle for hybrid and electric vehicles, are equipped with a multi-speed transmission, differential, summation or simple reducing gears. This is detrimental to noise, drive efficiency, energy regeneration, weight, space requirements and maintenance. ZAwheel, the gearless electric direct-drive with in wheel hub drives is consequently omitting any kind of transmission and has eliminated 80% of the moving parts in the drive train.

The in wheel hub drives are placed exactly where the torque is needed and where it is most efficient – directly in the wheel – with a total efficiency of the drive system of 90% (battery to wheel).

System comparison of different drive concepts for city buses

Three drive concepts, central-motor, electric portal axle and in wheel hub drive, used in a 12 m electric bus with a daily mileage of 200 km on 340 days a year, have been compared by a bus manufacturer. The bus was equipped according to the current standard of the respective manufacturers and the selected driving cycle SORT2. To ensure comparability, the tyre pressure and the total/overall vehicle weight (m 14,410 kg) have been adjusted accordingly. The results were clear:

Direct cost benefits
- Reduction of initial costs due to smaller battery pack (approx. minus 30 kWh)
- Reduction of annual operational costs thanks to low energy consumption (approx. minus 8,840 – 10,200 kWh)

Further benefits of ZAwheel
- Minimum installation space requirements
- Weight reduction
- Low maintenance
- Minimum noise characteristics (< 70 dBA at 80 km/h)
New vehicle or electrical retrofit: Retrofitting existing commercial vehicles as an advantageous alternative

In Europe, diesel engines are the main drives for trucks and buses. Around the world, reliable engines power the city, airport, sightseeing or double-decker buses plus municipal commercial vehicles and special vehicles in underground mines. Despite the many advantages, diesel engines emanate large amounts of toxic particles and nitrogen oxides and cause significant noise emissions.

So a large part of urban air pollution from existing fleets is caused by old, heavily polluting vehicles. A faster development towards better air quality is greatly hampered by the lengthy fleet replacement process, which can as long as 10 to 20 years. In addition, the current supply of zero-emission vehicles is still very limited and, for instance, all-electric zero-emission sightseeing buses are not available on the market.

However, any changes in the statutory regulations, such as the introduction of environmental zones, create an urgent need for action to be able to continue to operate these vehicles. Fleet operators have reacted globally by using zero-emission vehicles in order to totally avoid air pollution and noise emission.

ZAwheel scores in many areas, starting with the initial decision: The choice between buying new or retrofitting existing vehicles already provides the first cost advantage. When retrofitting existing vehicles, basically the drive train is replaced by the axle drive module and the required electrification is undertaken. Thanks to the significantly lower operating costs of ZAwheel compared to conventional systems, the acquisition or conversion costs are amortized in the foreseeable future.

ZIEHL-ABEGG Automotive and its partners have demonstrated their strength in the various mobility sectors: the great reduction of unwanted emissions while retaining the vehicle’s performance.
Vehicle manufacturer

VDL / Netherlands

Lider Trading / Poland

Hybricon / Sweden

Ekova Electric / Czech Republic

Troliga Bus / Slovakia

ebe-europa / Germany

Vehicle conversions / retrofits

City bus „The Whisper“ in Apeldoorn / Netherlands

City bus „e-Busz“ in Rotterdam / Netherlands
Simply convincing – The ZIEHL-ABEGG Automotive comprehensive service

**Consulting**
Individual, professional advice and extensive service are the strengths of ZIEHL-ABEGG Automotive. Based on detailed industry knowledge and trustful cooperation with our customers, we are able to provide the ideal drive module for every application in the commercial vehicle sector.

**Service**
As new developments come into operation, it is important to turn this crucial moment into a successful one. We offer – in addition to the support during the commissioning – a wide range of comprehensive services:

- Support for the mechanics by a specially trained field service
- Acceptance of new projects
- Measurement and troubleshooting as service support

**Spare parts**
Competence and speed are the hallmarks of the merits in the spare parts service at ZIEHL-ABEGG Automotive:
- Sophisticated logistics
- Original parts manufacturer quality
- Assemblies and service kits
- Spare parts even after discontinuation of the series

Vehicle monitoring – Online and in real-time

ZAwheel relies on two systems to achieve improved range and greater reliability of the vehicle while simultaneously reducing maintenance costs and experiencing less unplanned downtime.

**Online vehicle energy management**

The energy management system automatically and actively improves and stabilizes the range of the electric vehicle. That means measures can be taken in advance to react to the respective energy requirement and act to control the consumption or recharging. The energy management system provides an accurate online range prediction for the entire daily deployment.

**Real-time vehicle monitoring**
ZAwheel and the telediagnostics system are perfectly matched. All vehicle functions are thus checked online. Real-time analyses can reliably detect irregularities already in advance and proactively react to them. The system adds a new level of transparency in the diagnosis, analysis and monitoring of your buses:
- Online remote diagnosis inclusive active energy management
- All parameters in real time
- Exact location of the fault
- Extensive analysis functions in various stages
- Proactive maintenance feasible
- Authorization concept for data access