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ZF MOVES THE WORLD

ZF DRIVE SYSTEMS FOR
ELECTRIC LIFT TRUCKS
AND MATERIAL HANDLING
VEHICLES



MOTION AND MOBILITY

IAC / LIFT TRUCK 14 / EN
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STRONG SYSTEM PARTNER FOR MATERIAL TRANSPORT WORLDWIDE



ZF is a renowned specialist for driveline technology and recognized worldwide as an innovative system supplier for electric lift trucks and a wide range of material handling vehicles with combustion engine.

For many years already, ZF drive line and chassis systems have proven themselves in meeting the challenges of the market. The optimally matched system components – ZF transmissions, axles, and steering systems – provide a high level of efficiency and ease of handling. ZF innovations add up! They offer advantages for the driver, carrier and manufacturer in equal measure. Being part of the ZF Division Industrial Technology, the business unit Off-Highway Systems is the specialist for drive line systems that move all kind of material handling vehicles.

As full liner, ZF offers intelligent drive line solutions for enginepowered material handling vehicles up

to 60 tons lifting capacity as well as complete drive and steering solutions for electric lift trucks and warehouse equipment. From the smallest electric walker through to products for straddle carriers, aircraft tractors, RoRo- and yard tractors, and container handlers. The latest innovation offered by ZF is an electric steering system for material handling applications intended to replace the outdated hydraulic steering.

Dependable system partner

ZF took up the challenge of responding to permanent changes within the markets and developed into the technology leader for drive lines by supplying highly innova-

tive products. Today, ZF's responsibility starts from the project phase and extends via planning, product development, testing, volume production development, quality assurance and logistics right through to volume production. For system solutions, ZF benefits from the testing and development potential of all corporate divisions and uses this expertise to develop a wide variety of custom-tailored applications.

All ZF corporate divisions have production systems which are matched to the market-specific requirements. The six principles of these production systems are standardization and flexibility, process-orientation in customer-supplier-relationships, just-in-time, employee and team orientation, zero-error, as well as innovation and continuous improvement. The strict focusing of the company towards value-added processes along with the upgrading of all processes and products by innovations are the basis for customer benefit by leading technology.

In all phases of the product development ZF can rely on the global research and development network of the entire ZF Group. More than 5,000 development engineers guarantee on-going product innovation extending from fundamental and materials research right through to know-how transfer from the automotive sector. The Corporate ZF Research is also very strong in mechatronics and electronics development. In-house transmissions with integrated load sensors and telemetric system for example enable ZF to determine the stresses on the driveline in real lift truck application.

INTELLIGENT DRIVELINE SYSTEMS FOR DIESEL AND ELECTRIC LIFT TRUCKS



Vehicles employed in the field of material handling are indispensable for the smooth flow of materials within companies and for logistics applications. And the technology originates from ZF.

System solutions for electrically driven material handling vehicles

Transmission systems for electrically driven lift trucks of up to 6 tons lifting capacity are distributed by ZF under the name ERGOMAT. These systems include optimally matched components like traction motor, brake, drive wheel, frame plate, steering motor, and steering sensors – in fact everything needed for driving, steering, and braking. Front and rear drives for electric counter-balanced lift trucks and ready-to-install complete systems for any kind of warehouse handling equipment such as elevating work platforms, electric tractors, cleaning vehicles, automatically guided transport systems, or other special applications are developed and produced by ZF

with various alternative solutions (spur gear, helical bevel gear or planetary transmission) to suit individual customer requirements. ZF supplies fully tested solutions for quick and direct installation into the vehicle.

System solutions for vehicles with combustion engine

For diesel applications ZF supplies its ERGOPOWER transmissions for lift truck systems, reach stackers and straddle carriers, as well as container handling vehicles (so-called RoRo-/terminal- and yard tractors) of up to 330 kW engine power and gross combined weight ratings of up to 270 tons. By optimum matching of transmission hardware and electronic control, the ZF-ERGOPOWER units ensure

soft shift transitions in operation – a decisive criterion in practical lift truck applications. ZF-ERGOPOWER transmissions, which are tried and tested in the construction machinery, extend over a wide range of input torques from 750 Nm to 2,750 Nm.

Additional functions with the ZF Efficiency Package

A 5-speed or even 6-speed transmission is at the heart of the Efficiency Package, meaning fuel savings can be guaranteed due to engine speed reduction, higher productivity through better driving performance and higher shift quality, noise reduction and, last but not least, a higher number of gears which is the future standard. The improved ZF transmissions dispose of totally two to six forward and up to three reverse gears, which can be shifted manually or automatically and without interrupting the tractive force. Also available for the ZF-ERGOPOWER and Powershift series: Electronic inching. Actuating an inch or brake pedal allows the lift truck driver to reduce driving speed during operation to manoeuvre in a „creeper gear“ with-

out himself having to declutch or shift gear. This enables loads to be positioned sensitively and accurately to the millimeter. The expansion of functions to include electronic inching has become possible by the electro-hydraulic “ZF-ERGOCONTROL”, which ideally matches the functions of engine, converter and transmission.

Extended axle portfolio

ZF has extended its well-proven axle models to system applications in the field of materials handling. The new axle systems use the rugged drive line components found in off-road applications. The optimized axle structures are inherently suited to extreme conditions. The service brake is a high-performance, wet multi-disc brake. Very high stability and service life are achieved by active, integral oil cooling. A SAHR parking brake is also integrated. The axle is available with different rim hole patterns for solid and pneumatic tires in single or double configurations. Due to the modular design, individual adaptation to the vehicle frame, mast bearing and track width is decisively facilitated via the axle housing.

LESS CONSUMPTION Full utilization of the EFFICIENCY PACKAGE options for transmissions and axles allow fuel savings of up to 15%.

-15 %

ZF EFFICIENCY PACKAGE for improved efficiency and productivity

The modules of the EFFICIENCY PACKAGE not only reduce consumption and emissions, they also increase the service life of the components. The simple operation supports the driver in all working situations.

With the EFFICIENCY PACKAGE ZF is offering the system solution which perfectly matches the various components of the vehicle to one another. Transmissions, axle systems, and vehicle electronics are exactly tailored to the relevant requirements of the material handling machine. In this way the various advantages of the individual components are combined. This increases not only the operating and driving comfort, but also substantially improves the vehicle productivity. The individual modules of the package not only reduce consumption and emissions, they also increase the service life of the components. This in turn decreases the operating and service costs of the vehicles.

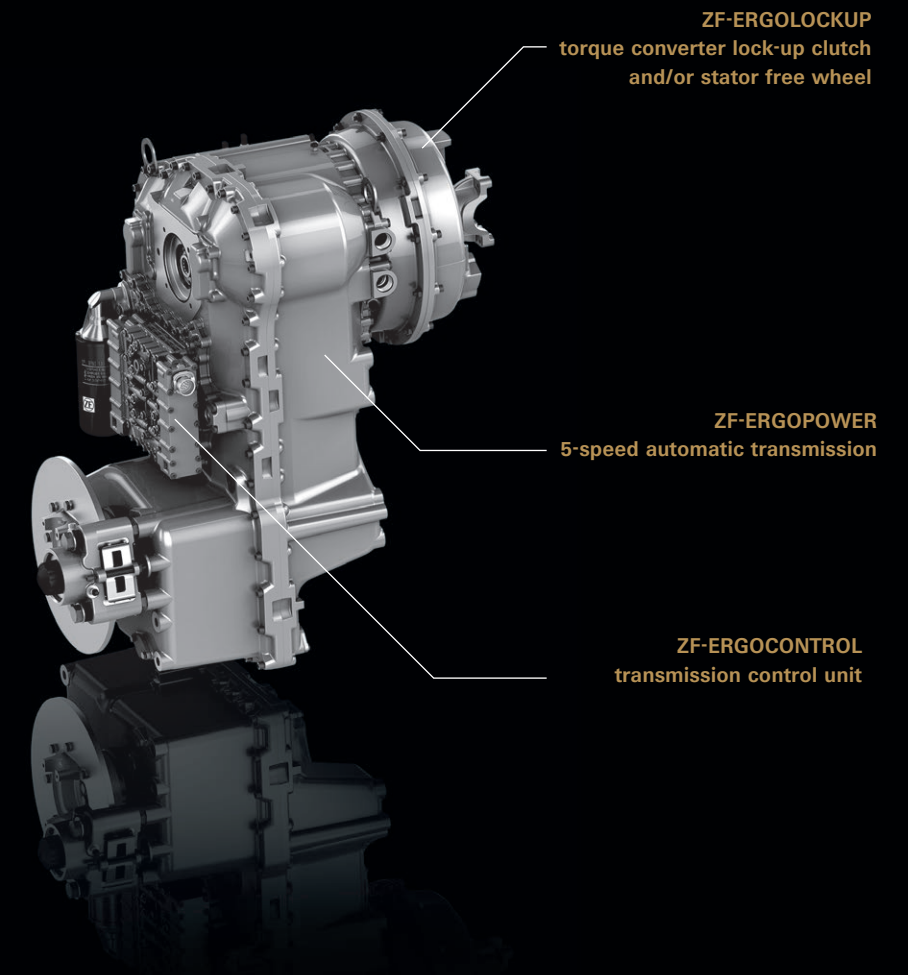
This approach makes it possible to reconcile the frequently conflicting demands for:

- less fuel and oil consumption
- reduced component wear
- increased productivity
- enhanced comfort
- extended service intervals
- noise reduction
- higher levels of automation
- improved shift quality
- easier operation

With the EFFICIENCY PACKAGE ZF consolidates its competence in the transmission, axle and functions development, thus offering more than the sum of individual advantages.

THE COMPONENTS OF THE EFFICIENCY PACKAGE

ZF offers 5- or even 6-speed transmissions in addition to the standard 3- and 4-speed versions. ZF focuses on Direct Drive in order to improve fuel consumption, tractive effort, speed and productivity. Direct Drive is engaged in most driving conditions. The lock-up clutch is opened automatically only when really needed and therefore operator abuse is avoided.



INNOVATION

STEERING SYSTEM EPS3

This electromechanical steering – a joint development by ZF and the company ZAPI, the market leader in electronic controllers for lift trucks – will soon be replacing the current hydrostatic steering systems in frontwheel-driven 3-wheel counterbalanced lift trucks. The electric lift truck is therefore consistently following the path trodden in the car industry a few years ago – substitution of hydraulic steering by energy-efficient electrical steering systems.

Principal features of the electromechanical steering:

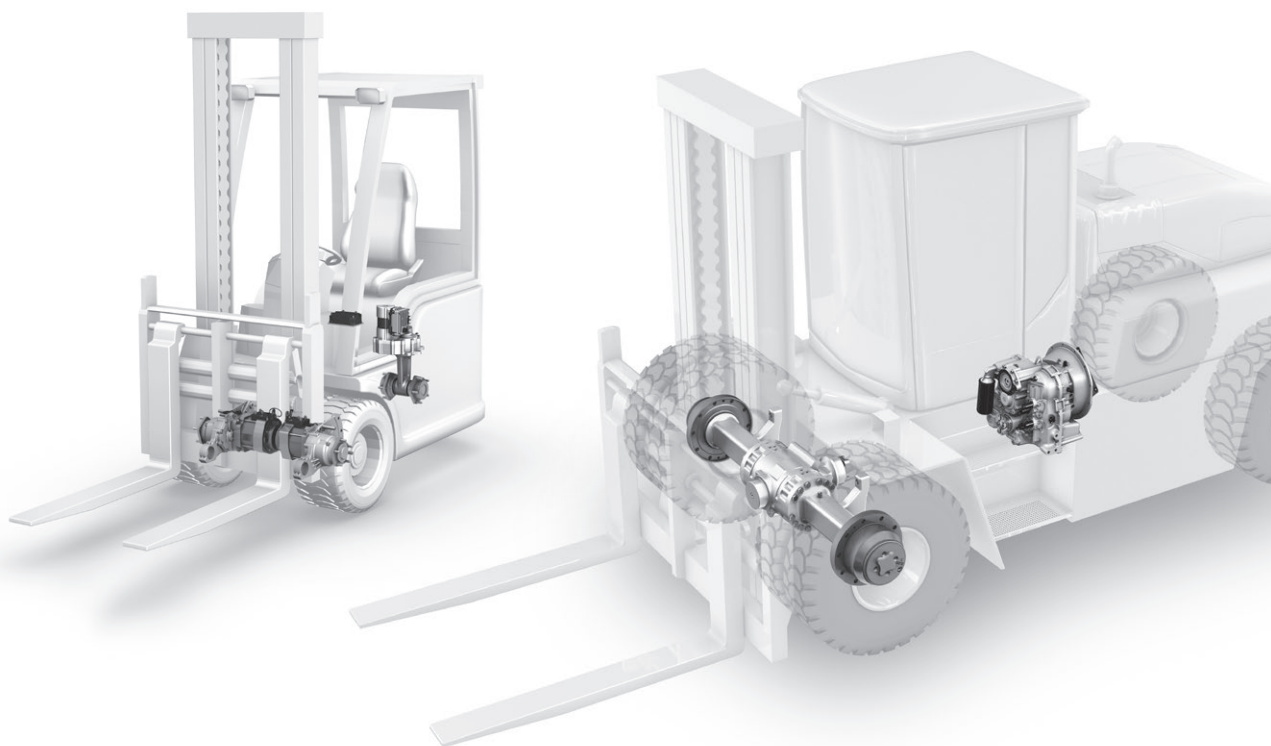
- Plug & play complete system with mechanical, electrical, electronic and software functions all from one source
- Significantly reduced installation complexity for forklift assembly
- Variable adaptation of the steering ratio
- Functional system safety according to DIN EN ISO 13849
- Certification to UL 583E
- Supply voltage from 24 to 48 V
- Protection class IP 65
- Steering angle max. +/- 135°

LESS ENERGY The electromechanical steering EPS3 allows more than 10% energy saving in the driving cycle.

-10 %



INNOVATIONS OF GREAT VALUE As a system supplier, ZF is one of the technology and innovation leaders worldwide in the field of material handling.

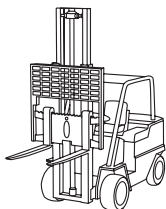


The manoeuvrability of a lift truck with a dual-motor drive is unbeatable. In this regard, ZF has long since set the standards and continues to develop them.

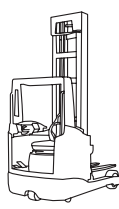
ZF offers efficient, simple handling and high, noise-optimized shifting quality with customer-oriented ease of service in material transportation vehicles.

ZF TECHNOLOGY FOR ALL LIFT TRUCK CLASSES

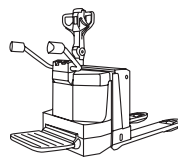
ITA CLASS 1
Electric counter-
balanced lift trucks



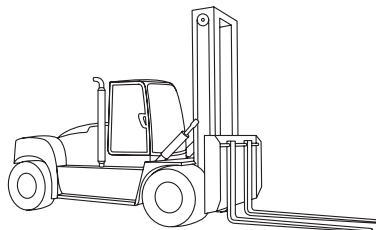
ITA CLASS 2
Electric warehouse
equipment



ITA CLASS 3
Electric walkies
and riders



ITA CLASS 4/5
Internal combustion
heavy material handling

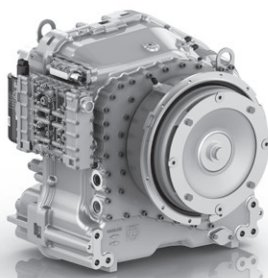


Learn more about our portfolio of powerful transmissions and find more ZF products by applications.

PRODUCTS ZF offers tailor-made transmissions and axles for a wide range of lift trucks and material handling vehicles.



ZF-ERGOPOWER "L" WG 311
for material handling vehicles



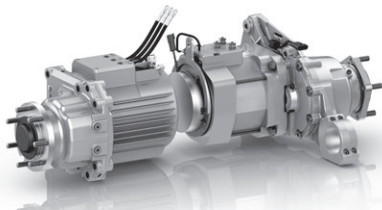
ZF-ERGOPOWER "M" WG 211
for material handling vehicles



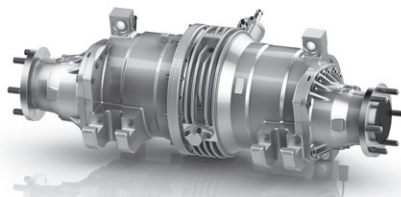
ZF-ERGOPOWER "S"
for material handling vehicles



MT-F 3000 axle system
for diesel-engined lift trucks



ERGOMAT GP 25 dual-motor drive system
for electric counterbalanced lift trucks



GPA 35 drive system
for electric counterbalanced lift trucks



EPS3 electromechanical steering
for 3-wheel counterbalanced lift trucks



GK 10 LD for electric walkies
and riders

OFF-HIGHWAY SYSTEMS

GLOBAL PRESENCE

ZF offers you a comprehensive and attractive range of products and services to ensure mobility anywhere, at any time. Proximity to the customer is an essential element of the corporate performance.

Customer satisfaction with the services and products provided by ZF is the topmost objective in all company activities. All services integrated into the product cycle, ranging from development and consultancy to aftermarket service are derived from this. Thus, proximity to international customers is of great significance to ZF.

Worldwide, the ZF Group has 121 production companies in 26 countries and eight main development locations. In addition to that, ZF has 32 service companies as well as 650 service points. This enables ZF to provide a dense network of highly qualified contacts close to international customers at all levels and in all regions.

The business unit “Off-Highway Systems“ with its headquarters in Passau, Germany, offers its customers individual, tailor-made integrated solutions for construction machinery, agricultural machinery and material handling applications. Off-Highway Systems has eight production sites worldwide: Passau (Germany), Steyr (Austria), Stankov (Czech Republic), Gainesville (USA), Sorocaba (Brazil), Hangzhou (China), Liuzhou (China) and Coimbatore (India). With a global development network ZF is able to adapt its products to the local requirements as well as to the series production support. All over the world the service network and central sales teams are available.

Tailor-made for the markets

This starts with engineering. Most ZF products, which are also produced outside Europe, first have to be adapted to local market conditions. On the one hand, this involves meeting the prevalent cost structures in each country without compromising on functionality and the hallmark ZF quality. On the other, technical specifications have to be adjusted to market conditions: Commercial vehicle transmissions have to be tuned to actual engine torque and average transport weights; shock absorbers designed to meet typical load profiles. ZF has a well-oiled international development network to fulfill these tasks: The main development locations are in contact with several customization locations near to the large, in-country ZF plants. Corporate R&D also coordinates and supports the activities at the development center in Tokyo (Japan). Jointly, they devise specific solutions in product design. In the case of product development and customization, the divisions control the process; the Corporate R&D locations are called in whenever fundamental research questions are involved.



LOCATIONS WORLDWIDE

