MAXIMUM TRACTION AND MOBILITY

ZF ALL-WHEEL DRIVE SYSTEMS FOR COMMERCIAL AND SPECIAL VEHICLES
THE EXPERT FOR ALL-WHEEL DRIVE TECHNOLOGY!

Its enthusiasm for innovative products and uncompromising desire for quality have made ZF one of the world’s leading drive and suspension technology Groups. ZF is also making a sustainable contribution towards designing the future with its „off-road“ applications. In industrial technology, ZF offers innovative technological solutions with the objective of improving mobility, increasing the efficiency of its products and systems and protecting resources – on land, on water and in the air.
For off-road applications and construction sites: ZF’s all-wheel drive technology guarantees perfect traction and is thus ideally suited for demanding tasks in difficult terrain.

All-wheel drive vehicles are universally applicable. They fulfill their transport duties under highly adverse driving conditions, both on and off the road. The perfectly aligned components of ZF’s all-wheel drive systems are at the heart of all modern all-wheel drive commercial vehicles, ensuring reliable, safe, and economical driving performances, even under difficult driving conditions. ZF delivers gearboxes, axles, and the high-tech package ADM 2 – Automatic Drive-Train Management – specifically for all-wheel drive trucks, commercial and special vehicles. The intelligent ADM 2 automatic control electronic connects the driveline components to form a perfectly aligned system which noticeably enhances off-road capability, safety, and driving comfort.

**ZF is the all-wheel drive expert for commercial vehicles**

Our major strengths are the consistent technical further development of the all-wheel drive technology and our capability to fulfill customer requests on short notice. As an expert for driveline and chassis technology, ZF has the necessary experience and know-how at hand in order to meet the customers’ individual requirements. From the concept to the prototype and testing in practice - we offer our customers the entire range of product engineering and design.
We make a decisive contribution to the continued improvement of all-wheel drive technology in commercial and special vehicles, right down to the fully automated driveline. The result is maximum driving safety thanks to improved stability, traction, and user friendliness, which relieves the driver, particularly when driving in difficult off-road terrain.

The driveline has to withstand extreme uphill and downhill gradients, sandy grounds, and low waters. Therefore, ZF offers products which have been modified especially for such requirements. This means that permanent operability is guaranteed, also in the most adverse conditions.

On customer request, ZF develops all-wheel drive solutions for special requirements and is thus able to serve niches and offer special concepts in addition to large production volumes. ZF provides the customer with a complete solution for the entire product life cycle, from design and engineering to production and even worldwide spare parts supply after volume production phase-out. The portfolio includes customer-specific all-wheel drive axles and transfer cases, which benefit from state-of-the-art development, testing, and production methods according to ZF Group standards guaranteeing top quality and maximum reliability.
The ZF steering axle for all-wheel drive trucks stands out with its generous ground clearance, long service life, and robustness. Its superior technology improves propulsion and performance while reducing costs.

Designed for the modern construction site truck with a front axle load of 10 tons, the APL 90 axle with 100-percent differential lock allows for safe propulsion even in difficult operating conditions. Additionally, it is possible to apply the ADM locking technology. The planetary drive design in the wheel ends reduces the weight and helps to maximize ground clearance. With its maintenance-free steering-knuckle bearings and generous oil change intervals, the APL 90 reduces operating costs too.

The laterally placed input shaft allows for a low position of the engine and transmission, thus lowering the step-in level for the driver. Balanced steering kinematics with a small scrub radius make the vehicle easy to maneuver, which results in reduced tire and road surface wear. An ABS-controlled drum brake, which is particularly well suited for demanding off-road applications, rounds off the axle concept.
**STEERING AXLE FOR ALL-WHEEL DRIVE TRUCKS** Precise steering, uncompromising reliability – The APL 90 steering axle meets the challenges of day-to-day construction site work with ease.

<table>
<thead>
<tr>
<th>SPECIAL FEATURES</th>
<th>TECHNICAL DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance-free input shafts</td>
<td>APL 90</td>
</tr>
<tr>
<td>Protected brake actuation</td>
<td>10 000 kg</td>
</tr>
<tr>
<td>Preset bearings</td>
<td>Output torque max.</td>
</tr>
<tr>
<td>Easy oil level check</td>
<td>35 000 Nm</td>
</tr>
<tr>
<td>Maintenance-free kingpin bearing</td>
<td>Typical tires</td>
</tr>
<tr>
<td>Protected tie rod</td>
<td>13.00 R 22.5</td>
</tr>
<tr>
<td>ADM 2-capable</td>
<td>Gear ratio</td>
</tr>
<tr>
<td></td>
<td>5.19: 6.89</td>
</tr>
<tr>
<td></td>
<td>Brake</td>
</tr>
<tr>
<td></td>
<td>Drum</td>
</tr>
<tr>
<td></td>
<td>Axle weight incl. oil fill</td>
</tr>
<tr>
<td></td>
<td>742 kg</td>
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<tr>
<td></td>
<td>Differential lock</td>
</tr>
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<td></td>
<td>100%</td>
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</table>

www.zf.com/truck
ZF has decades of experience in the development and production of transfer cases. They are used in a wide variety of civilian and military all-wheel drive vehicles.

The transfer case is the most important driveline component in any all-wheel drive vehicle. It distributes the propulsive power which comes from the engine and the main gearbox to the front and rear axles. ZF is world market leader of transfer cases for all-wheel drive vehicles starting at 9 tons total weight, and is supplier of all major, renowned commercial vehicle manufacturers worldwide, apart from some very few exceptions. ZF provides for a highly comprehensive program of transfer cases which are available for input torques of 10 000 Nm to 35 000 Nm and are designed for the medium-duty and heavy all-wheel drive commercial vehicle sector. The underlying modular system enables ZF to offer a multitude of customized transfer case versions and solutions. Engine power and torque ranges are rising continuously. With the VG 2700 transfer case, ZF offers driveline technology which has been specifically designed for the strongest engines in heavy all-wheel drive vehicles. With a maximum input torque of 35 000 Nm, the VG 2700 is the most powerful volume-production transfer case worldwide.

The compact design of the VG model range makes vehicle installation easier and more cost-effective, while the 2-speed system of the transfer cases allows for high off-road capability and mobility. All ZF transfer cases can be equipped with the ZF-ADM 2 (Automatic Drive-Train Management) function; thus, this is an essential element of overall driveline performance enhancement for all-wheel drive commercial vehicles.

**ZF transfer cases are characterized by:**
- Compact and weight-optimized design
- High input speeds
- Integrated oil pump (optional), for external cooling
- Operation of up to two emergency steering pumps
- Two shaft distances available (VG 1600 / VG 2000)
- Compatible with ADM 2
- Optional: Engageable PTO (2 000 Nm)
**ZF TRANSFER CASES** are extremely reliable and characterized by optimal power distribution. They also prove valuable under toughest conditions: Winning vehicles in the commercial vehicle category of the Dakar Rally had ZF systems on board.
The ZF-ADM 2 (Automatic Drive-Train Management) is an ideal, optional complement to the ZF transfer cases and axle components. The further development of the electronic system, consisting of mechanical components, electronics, and software, automatically controls all axle and transfer case differential lock shifting functions and rules out incorrect handling.

ZF-ADM 2 guarantees 100 percent of physically possible traction at all times, along with optimal driving dynamics, higher vehicle stability in off-road terrain, and a noticeable relief for the driver who can concentrate on the driving situation.

The central components of the system are ZF-ADM dog clutches, installed in axles and in ZF transfer cases. The independent electronics communicate with a number of sensors via CAN bus. Speeds of all wheels are measured and compared with each other by speed sensors. When slip is detected on one of the wheels, the control unit detects the speed difference and automatically activates the differential locks within 100 milliseconds. Furthermore, the locks remain active only as long as there is missing traction on one or more wheels. As soon as the differential locks are not needed anymore, they open automatically by spring force. Thus, both mechanical damage to the driveline and incorrect operation by inexperienced drivers are prevented. With ADM, the driver does not have to pay permanent attention to ground conditions anymore and does not have to stop in order to manually engage the differential locks. This is done fully automatically on the fly, which results in a safer and faster drive. ZF-ADM contributes notably to increasing safety – both on the road and in difficult terrain.

The ADM 2 automated driveline management gives you a decisive head start. Driving conditions are continuously measured and the driveline components are shifted accordingly.
**DRIVE-TRAIN MANAGEMENT** Innovative technology always has multiple aims: ZF-ADM 2 eases the strain on the driver and the material, while at the same time reducing costs and wear.

- During driving, the axle and transfer case differential locks are automatically activated and deactivated at the right moment
- 100 % of physically possible traction is available at all times
- Higher level of vehicle stability and driving safety
- Relief for the driver
- Less driver training required

- No driveline damage due to incorrect operation
- Longer vehicle service life
- Less tire wear
- Reduced fuel consumption (up to 7 %)
- SIL2 safety class of the control unit
- Worldwide support thanks to standardized „ZF-Testman“ diagnostic software

**REDUCED FUEL CONSUMPTION up to**

-7 %
Mobile, reliable, and safe – the demands military forces place on the drive-line and chassis of their wheeled and tracked vehicles are high. With the axle components of the APE model range, ZF meets these demands.

ZF offers different versions of wheel heads and axle center drives for protected, wheeled all-wheel drive vehicles. The APE model range has been designed for axle loads from 3 to 10 tons and for wheel configurations from 4x4 to 10x10. The planetary axles of the APE model range are independent suspension axles, without axle bridges. The center drives are directly mounted to the vehicle’s chassis while the wheel heads are individually suspended. The input torque is transferred from the center drives to the wheel heads. Compared to conventional axles, the independent axle design results in a lower total height of the vehicle with unchanged ground clearance.

ABS sensors on the center drives and a pneumatic lead through for the central tire inflation system in the wheel heads are standard. Optionally, the center drives are equipped with lubricating pumps and can be supplied with external oil cooling if required. As all axle components are fordable they can also be used in amphibian vehicles.

The modular design of the APE model range facilitates customized adaptation to the installation situation in the vehicle. For an ideal design of the driveline, it is possible to choose between lockable interaxle differentials, engageable drive shafts to additional axles, and numerous other functions. The axle components are suitable for various suspension systems as well as for all commercial tire and wheel sizes. Different options for torque flow (differentials and locks) enable optimal adaptation to the requirements in difficult terrain. Optionally, it is possible to mount the ZF transfer cases directly to the axle drives. This results in a compact design of the drive train system.
AXLE COMPONENTS OF THE APE MODEL RANGE are designed for use in difficult terrain. Their advantages are smaller unsprung masses compared to a rigid axle and their flexibility to adapt to the optimal vehicle design.

<table>
<thead>
<tr>
<th>Designs</th>
<th>APE 60 Wheel head RP3000</th>
<th>APE 60 Center drive BK</th>
<th>APE 60 Center drive BK-DU</th>
<th>APE 60 Center drive BK-DUA</th>
<th>APE 100 Wheel head RP5000</th>
<th>APE 100 Center drive CK</th>
<th>APE 100 Center drive CK-7</th>
<th>APE 100 Center drive CKZ-7</th>
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<tbody>
<tr>
<td>Axle load max. [kg]</td>
<td>6,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Input torque max. [Nm]</td>
<td>5,700</td>
<td>9,400</td>
<td>9,400</td>
<td>9,400</td>
<td>9,200</td>
<td>14,800</td>
<td>14,800</td>
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<tr>
<td>Input speed max. [rpm]</td>
<td>2,500</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>2,400</td>
<td>3,500</td>
<td>3,500</td>
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<tr>
<td>Gear ratio</td>
<td>5.20</td>
<td>1.32</td>
<td>1.32</td>
<td>1.32</td>
<td>5.75</td>
<td>1.31</td>
<td>1.31</td>
<td>1.31</td>
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<tr>
<td>Direct mounting of a ZF transfer case possible</td>
<td>-</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>-</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Weight [kg]</td>
<td>104</td>
<td>153</td>
<td>190</td>
<td>226</td>
<td>180</td>
<td>190</td>
<td>237</td>
<td>265</td>
</tr>
</tbody>
</table>
Our enthusiasm for innovative products and processes and our uncompromising pursuit of quality have made us a global leader in driveline and chassis technology. We are contributing towards a sustainable future by producing advanced technology solutions with the goal of improving mobility, increasing the efficiency of our products and systems, and conserving resources.

Our customers in the automotive and industrial sectors welcome our determined focus on products and services, which provide great customer value. Improvements in energy efficiency, cost-effectiveness, dynamics, safety, and comfort are key to our work. Simultaneously, we are aiming for continuous improvement in our business processes and the services we provide. As a globally active company, we react quickly and flexibly to changing regional market demands with the goal of always providing a competitive price/performance ratio.

Our independence and financial security form the basis of our long-term business success. Our profitability allows us to make the necessary investments in new products, technologies, and markets thus securing the future of our company on behalf of our customers, market affiliates, employees, and the owners of ZF.

Our tradition and values strengthen our managerial decisions. Together, they are both an obligation and an incentive to maintain a reliable and respectful relationship with customers, market affiliates, and employees. Our worldwide compliance organization ensures that locally applicable laws and regulations are adhered to. We accept our responsibility towards society and will protect the environment at all of our locations.

Our employees worldwide recognize us as a fair employer, focusing on the future and offering attractive career prospects. We value the varied cultural backgrounds of our employees, their competencies, and their diligence and motivation. Their goal-oriented dedication to ZF, beyond the borders of their own field of work and location, shapes our company culture and is the key to our success.
ZF Lenksysteme GmbH is a joint venture of ZF Friedrichshafen AG and Robert Bosch GmbH.