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Go ahead. We move it.

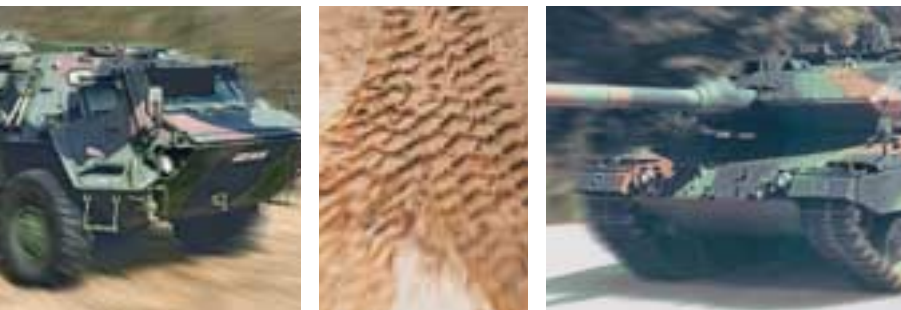


Driveline technology for military vehicles

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LACON design



Driveline and Chassis Technology



“A vehicle is only as good as the interaction of its individual components. Therefore, real development partnership with manufacturers is required for high performance.”



Dr. Thomas Hegel,  
Director, Business Unit ST

Military vehicles are not mass-produced. Their technical concept is developed specifically for each vehicle, sometimes component by component. Individual customer innovation requires close, equal cooperation with the vehicle manufacturers in addition to the experience and the know-how that spans across our company. The result: High performance in product development, manufacturing, and startup. Whenever possible, we build on components from high-volume production for cars and commercial vehicles.

Particularly in the military sector, technology must be reliable and enduring. ZF Special Vehicle Transmissions customers can therefore expect our full support for product management, maintenance, and technical updates. Go ahead. We move it.

Dr. Thomas Hegel



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# High performance

Experience pays: ZF driveline technology for military vehicles



Military vehicles must perform versatile functions, withstand extreme on or off-road loads, and demonstrate high performance under the harshest conditions. What reliably advances them are the quality and potential of ZF Special Vehicle Transmissions.

Transmissions, suspension, steering, or braking technology – ZF has experience in all areas. We employ interdisciplinary company know-how to develop and manufacture powerful solutions specially designed for the military sector. At the same time, we work closely and equally with vehicle manufacturers and government offices. In economic terms, our customers profit from ZF's high volume production for cars and commercial vehicles. Often, high-volume products can be adapted for military vehicles or system components can be taken from high-volume production.

A further cost advantage: While product development cycles are shortened by our development partnership with manufactures, service life cycles become longer. The modular design of ZF product systems enables simple maintenance, service, and further development. In conjunction with guaranteed spare parts supply and high service quality, this ensures that wheeled and tracked vehicles are ready for action for decades to come.

# Ready for action

Automatically always the right shifting strategy: ZF transmission systems

Engine performance, available installation space, planned application – every military vehicle presents different requirements for transmission design and performance. Furthermore, it must be robust and easy to operate as rough terrain and difficult situations demand everything the driver as well as the technology can give.

Our recommendation: ZF automatic transmissions. They are geared exactly to the vehicle, relieve the driver of all clutch and shift work, and therefore prevent stress-related operating error. This is performance you can rely on. Since 1925 we have been pioneers in automatic technology.

The core piece of the ZF automatic transmission is an electronic transmission control. It is programmed specifically for each vehicle and it communicates with other vehicle components via CAN in newer transmission generations. Taking into account the load, acceleration, and braking situation, it can calculate the optimal gear setting and shift point. If the wheeled or tracked vehicle's application changes, the electronics are adapted or replaced. The control module is available in shockproof metal housing as an option, which according to the NATO standard also prevents electromagnetic interferences.





ZF-3 HP 220 / ZF 4 HP 220 / ZF-6 HP 260

Light-duty military "high-mobility" wheeled vehicles with all-wheel drive are making the best progress on and off-road with the hydraulic planetary gears ZF-3 HP 220, ZF-4 HP 220, or ZF-6 HP 260. Shifting between the three, four, or six forward gears takes place without traction interruption. In the ZF-6 HP 260, the shifting point and gear are pre-set by the transmission electronics in coordination with the other vehicle components via CAN.

## Reliability

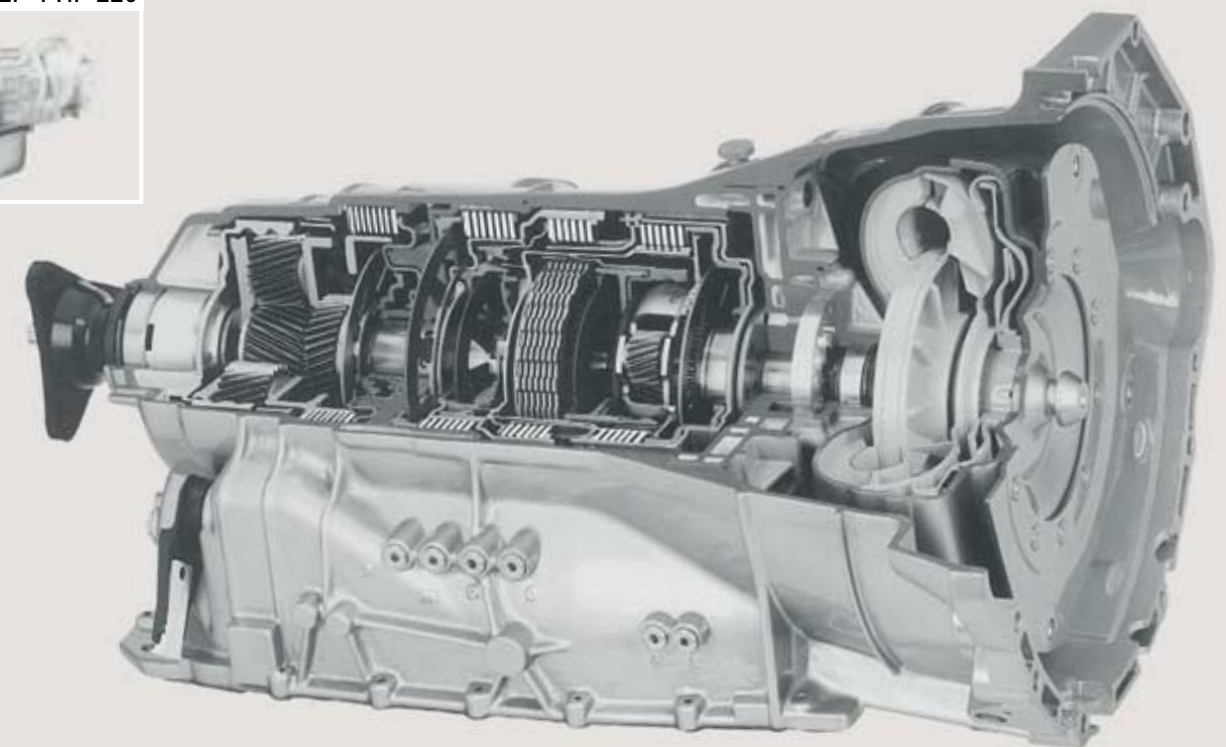
In action on and off-road: ZF automatic transmissions for wheeled vehicles

A hydrodynamic torque converter increases the engine torque and makes starting off and quick acceleration jerk-free in both forward and reverse gears. In higher gears, the torque converter is bypassed depending on speed and the position of the gas pedal. This saves fuel and costs.

ZF-3 HP 220



ZF-4 HP 220



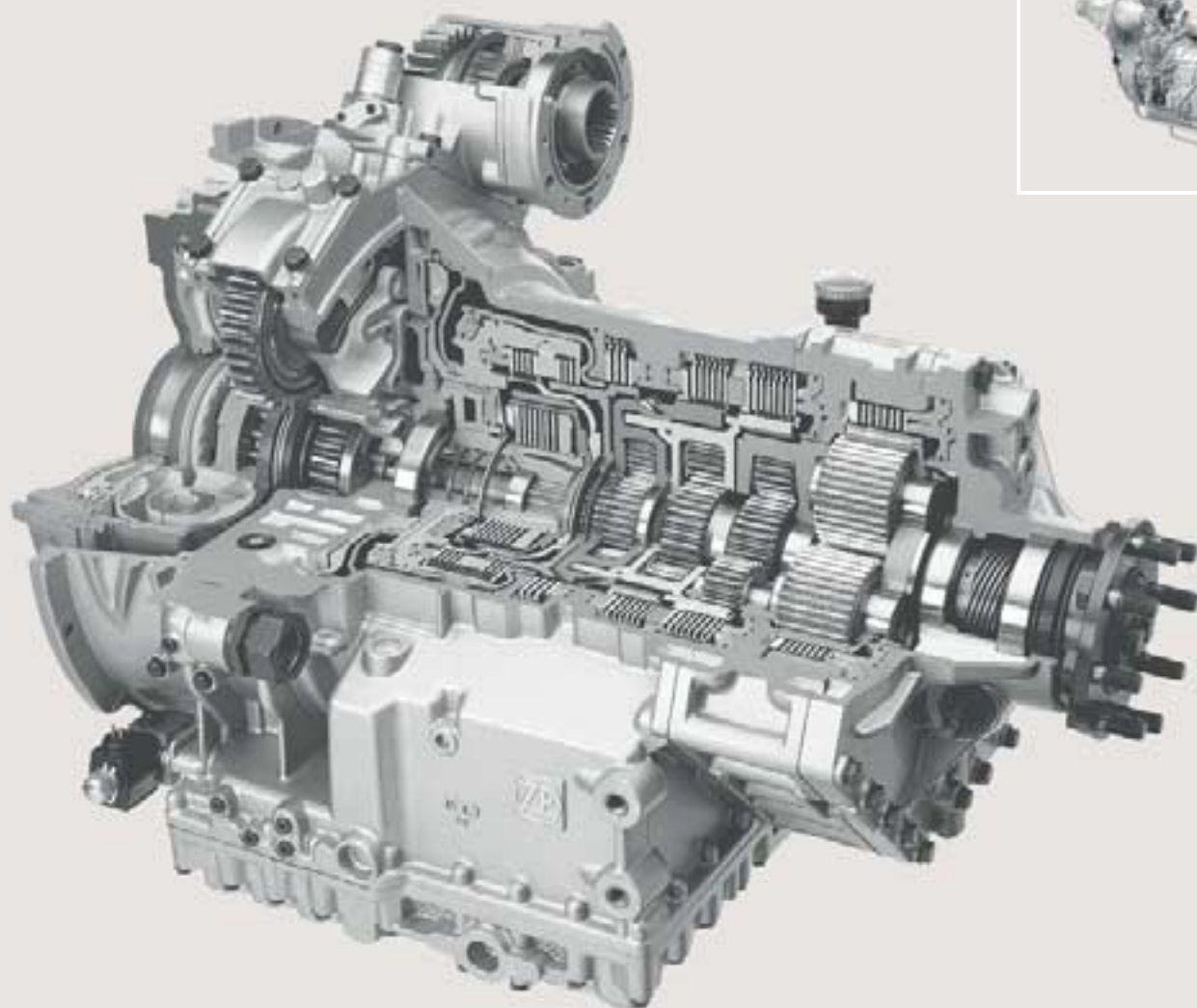
ZF-6 HP 260



ZF-HP 502 S / ZF-HP 602 S / ZF-HP 902 S



ZF-6 HP 600  
+ STV 550 + A 800/3D



ZF-HP 902 S

Medium and heavy-duty armored wheeled vehicles as well as extreme off-road, multi-axle or all-wheel drive military trucks meet their objectives with ZF HP series transmission systems.

Without interrupting tractive power, these systems shift automatically between the five to seven gears. By increasing the engine torque, the integrated torque converter makes starting up jerk-free even on steep inclines. The torque converter is bypassed as soon as the vehicle gains speed. This saves fuel and costs. The primary retarder – a standard feature – adds additional braking safety. It demonstrably reduces wear on the service brakes by up to 90%. The new generation of ZF HP transmissions is in constant contact with the other vehicle systems via CAN.

In each transmission, different, motor-dependent power take-offs combine via two output drive positions to power additional units. In addition, an emergency steering pump as well as a secondary pump can be installed to supply the transmission with oil when the vehicle is towed.

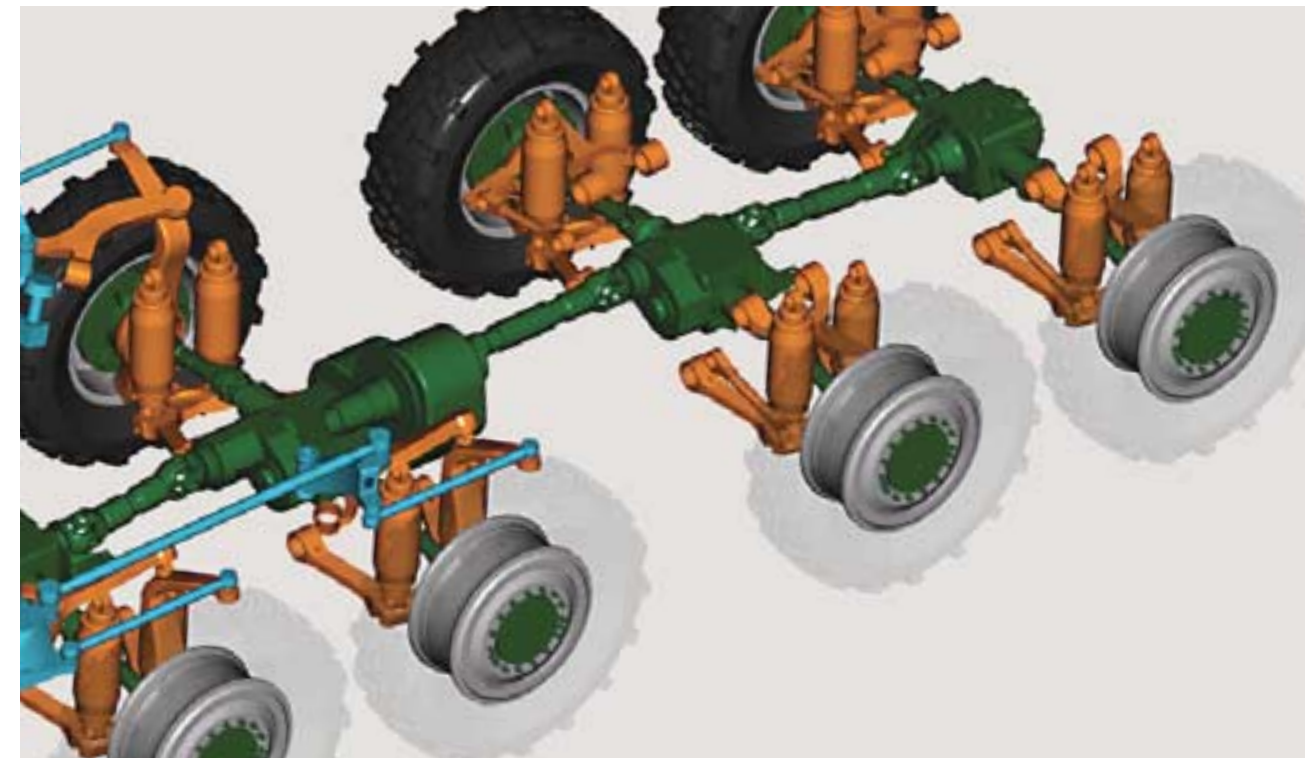


## ZF AS Tronic technology

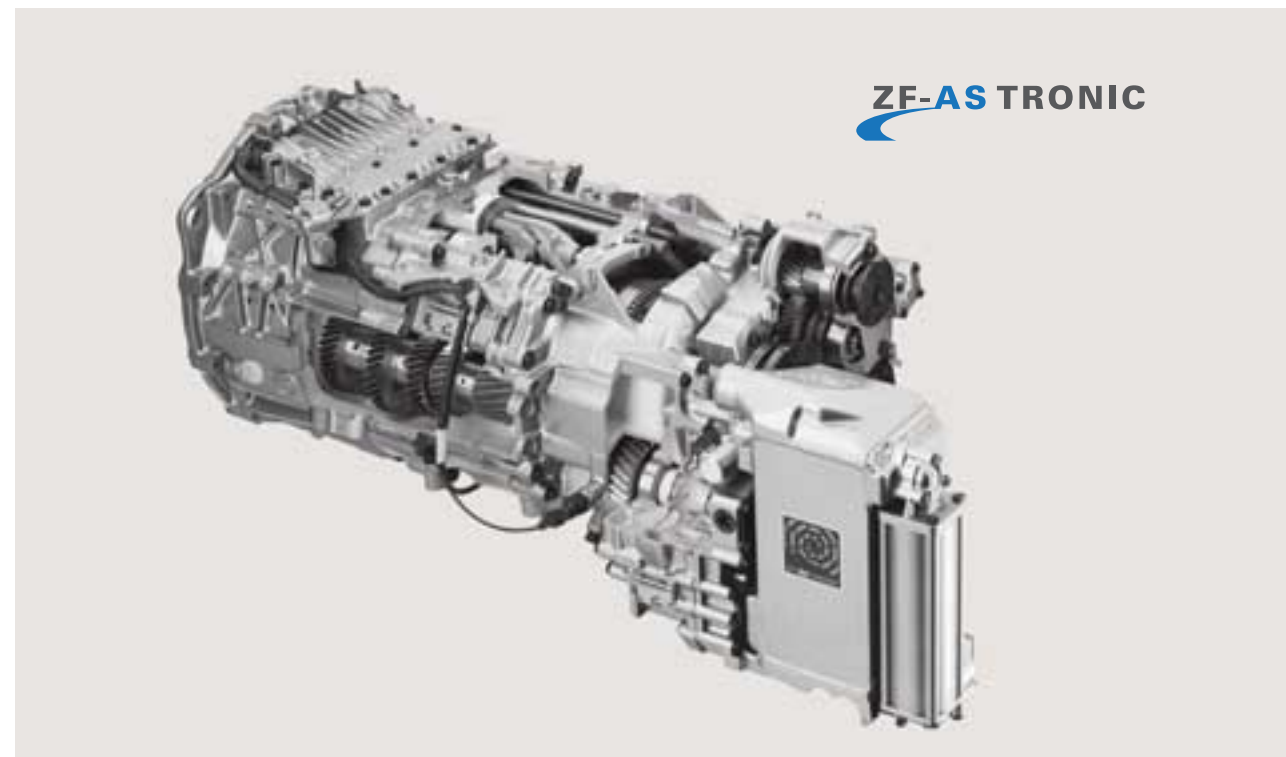
The automatic transmission systems of the ZF AS Tronic family are well-suited for "medium-mobility" vehicles, troop transport vehicles, bridge layers, etc.

The transmission electronics connected with the vehicle systems, such as EDC motor, ABS, and ASR, automatically provide for the optimal shifting point and gear in each driving situation here as well. By contrast with "conventional" automatic transmissions, the driver can intervene and

manually shift gears at any time. The transmission takes care of clutch and shift work regardless of the drive mode. ZF AS Tronic technology may be used in wheeled vehicles of various weight classes – in heavy-duty tank-transporting vehicles, for example, with TC Tronic equipped with torque converter clutches. Each system can be combined with up to two drive or clutch-dependent power take-offs.



Military wheeled vehicles are often deployed to travel straight across the terrain. Maneuverability and climbing ability are required in addition to speed. Every type of terrain, every obstacle, and every ditch must be easily overcome, with the vehicle also creeping along close to the ground in "silent-watch-mode."



## Mobility

Optimal tactics for the terrain: ZF suspension components for wheeled vehicles

In order for the transmission power to be transmitted to all wheels and to safely steer the vehicle even on rough terrain, the transfer case must operate reliably, axle components and wheel suspensions must prove flexible, and steering/braking systems must be adjusted perfectly to the vehicle concept. ZF offers powerful individual components which can be combined with individual systems depending on customer requirements.



ZF-LSG 300 / ZF-LSG 1000

The ZF LSG 300 is a 4-speed automatic transmission with torque converter and hydrostatic superimposed steering system for small, light-duty Wiesel 2 type tracked vehicles. Shifting occurs automatically without any loss in tractive power. The shift electronics geared to the vehicle application interacts with the other vehicle systems. The Wiesel 2's maneuverability is based on its continuously variable steering. Turning is also possible around the vehicle's vertical axis. A motor-dependent power take-off can be combined.

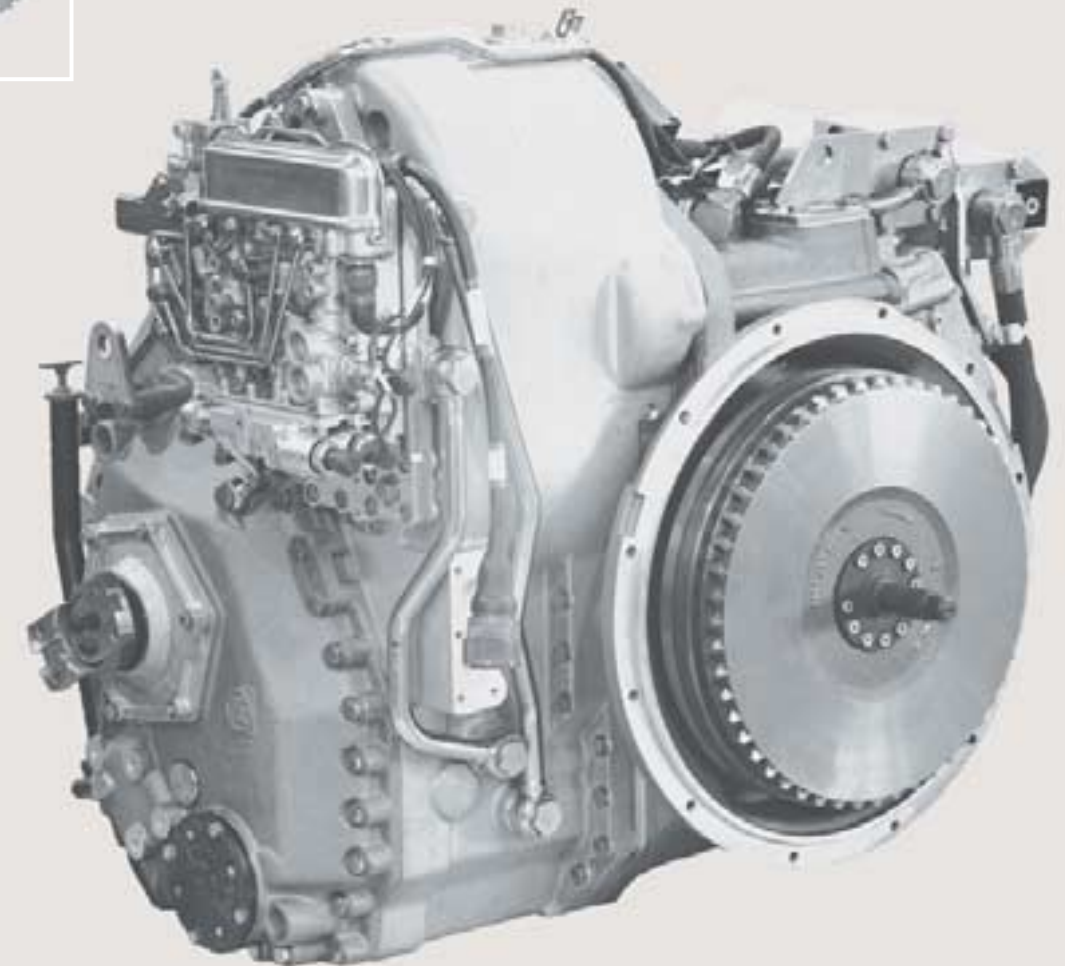
## Safety

Trend-setting technology: ZF steering gears and manual transmissions for tracked vehicles.

Light-duty front-drive tracked vehicles up to 21 t have driven for years at the highest power and safety level with the ZF LSG 1000 steering gears and manual transmissions. The automatic gear shift changes between the six forward gears and the two reverse gears in coordination with E-gas or EDC vehicle components via CAN without interrupting the tractive power. On the one hand, the large gear ratio range enables high speeds; on the other hand, it gives the vehicle excellent climbing ability. An integrated torque converter makes starting up and accelerating easier by hydrodynamically increasing the engine torque. When it is automatically locked up can be programmed for each gear. If the automatic fails, the mechanical emergency circuit enables driving in one forward or reverse gear.

The hydrostatic superimposed steering gear enables continuously variable, fingertip steering and turning around the vehicle center. And all this takes place simply and safely per steering wheel because the steering and braking systems are separate in the ZF LSG 1000. Whether going forward or backward, steering is homodirectional, as in a car. It turns off when the transmission is shifted into neutral. The enclosed engine compartment in tracked vehicles requires extreme cooling capacity. Therefore, the ZF LSG 1000 can power an additional fan pump via a motor-dependent power take-off.

ZF-LSG 300



ZF-LSG 1000



ZF-P 25000



In heavy-duty tracked vehicles up to 62 t, the ZF final drive ZF P 25000 transmits driving and braking power to the tracks. With the ZF P 25000, the planetary gear can increase the torque directed from the motor through the transmission by a factor of up to 4.67. It is well-suited for vehicles with front or rear drive, can be installed left or right, and, thanks to interchangeable driving sprockets of various sizes, can be used for various track widths.

## Load capacity

Tough: ZF final drives for tracked vehicles

Powerful acceleration, braking, shocks, and aquatic applications (fording) – no problem for the robustly designed ZF P 25000. The final drive is marked by high load capacity; extremely loaded components are lubricated directly by means of an integrated oil pump.

ZF P 25000 can be installed in vehicles of various widths because the main transmission and final drive are connected to one another through variable sliding sleeves. Little time is needed to separate and dismantle the transmission and final drive. Maintenance is simple. Service and parking brakes can be installed at request.

# Endurance

Up to date for decades: Retrofitting programs

The high investment costs in military vehicles call for long service life. Yet engines, vehicle technologies, legislation, and safety regulations continue to evolve. The solution: Retrofitting programs. ZF works in close cooperation with vehicle manufacturers so that the vehicle concepts are successfully upgraded and the individual updated components and systems integrate optimally into the network. An additional advantage of ZF products: Their modular design simplifies both replacement as well as integration with other vehicle components.

M 113: The “G3” retrofitting program.

The scheduled service life for the M 113 ends in 2025. The first two generations of this vehicle type ran with transmissions which had coupled braking and steering functions. The driver used to steer the vehicle with two control levers to accelerate one track and brake the other depending on the desired direction. A risk factor: Braking and steering interfered with each other. Therefore, ZF was involved in the G3 upgrade phase and, in cooperation with FFG, MTU, and German government offices, developed a transmission system that solves this safety problem: ZF LSG 1000. Steering and braking functions were separated. The driver operates a steering wheel for directional control and the tracks are automatically accelerated and decelerated. Braking is performed with a pedal. ZF LSG 1000 meets all NATO requirements and EU safety regulations; it was successfully tested and has been deployed in peacekeeping missions by the German, Danish, Norwegian, and Australian armies.





# Support

For long service life:  
ZF customer service

ZF customer service in the military sector begins with product development and continues partly over the entire vehicle service life.

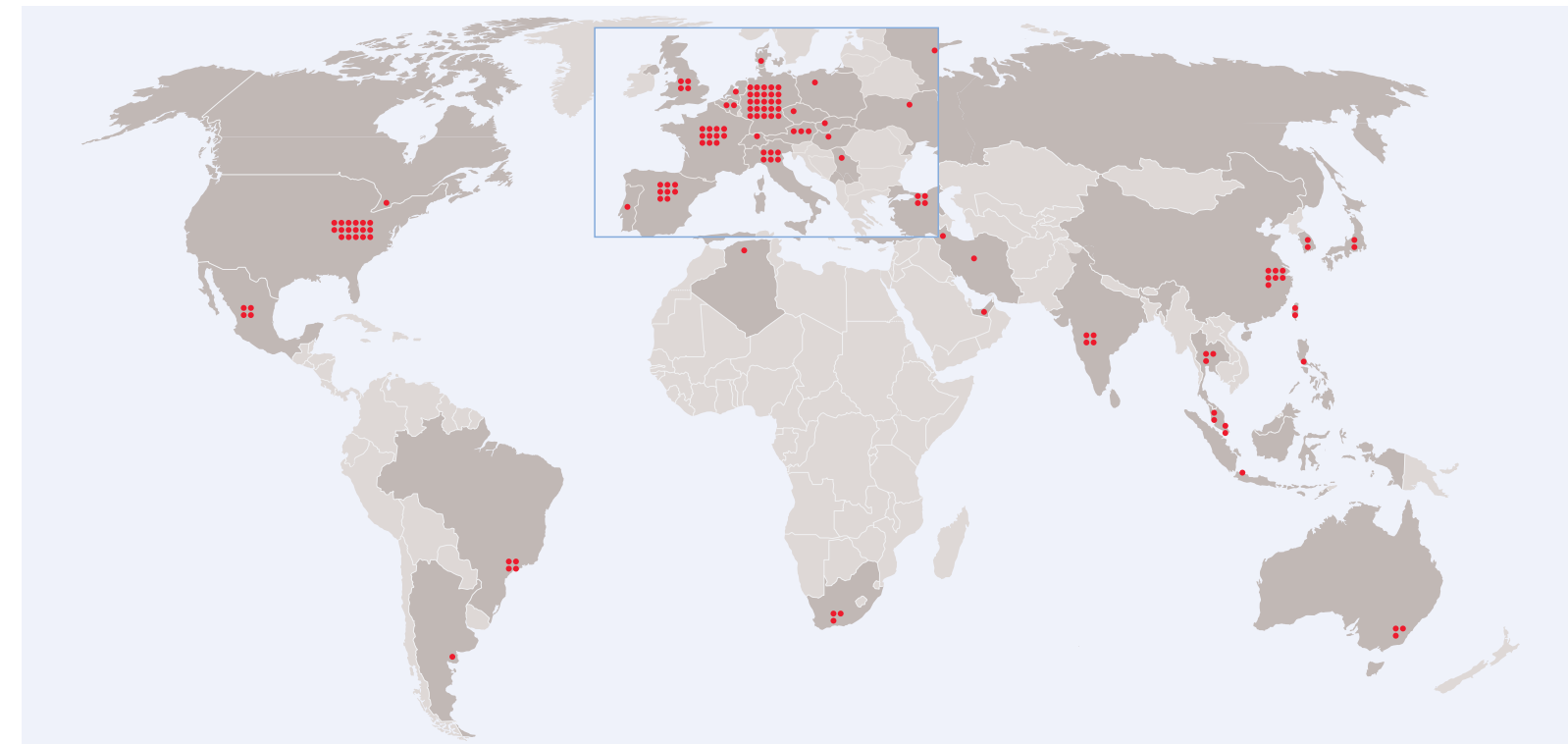
We maintain our systems 20 years or longer, regardless of whether the systems in question are still manufactured. ZF guarantees the supply of original spare parts for ten years after volume production has ceased. The ZF plant in Friedrichshafen is the service center for ZF military vehicle components. Worldwide maintenance and spare part supply is coordinated from here. Our overhaul center is also located in Friedrichshafen where we overhaul vehicles from domestic and foreign armed forces from scratch and develop product updates.

ZF trains driving and maintenance teams for military vehicles on site or in Friedrichshafen. The teams are introduced to the technology, trained to handle the vehicles and, for example, to install and remove transmissions.

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### Locations

- 119 Production Companies
- 6 Research and Development Centers
- 27 Sales and Service Centers and Representative Offices
- 28 Aftermarket Trading Companies
- More than 500 After Sales Service Points worldwide

# Innovation

Drive with a future: E-Drive

Comprehensive knowledge and many years of experience make up our innovative potential. Building on this, we develop product strategies for the markets of the future.

One example: E-Drive. An electrical drive concept, with which tracked and wheeled vehicles – without gear train – advance both silently as well as environmentally-friendly via power-optimized

E motors. The design is flexibly adapted to the respective installation conditions.

Hybrid drives are planned for the first generation, which will be operated based on hydrogen via generators, batteries, or fuel cells in combination with diesel fuel. In the second phase, “all-electric-vehicles” will demonstrate motive power.





# Overview

## Transmissions available for wheeled vehicles

	Number of gears	Input torque [Nm] / [lbft]
3 HP 220	3	210 Nm / 155 lbft
4 HP 220	4	350 Nm / 260 lbft
6 HP 260	6	600 Nm / 445 lbft
HP 502	7	1200 Nm / 885 lbft
HP 602	7	1600 Nm / 1180 lbft
HP 902	7	2000 Nm / 1475 lbft
12 AS 1602	12	1600 Nm / 1180 lbft
12 AS 2302	12	2300 Nm / 1695 lbft
12 AS 2602	16	2600 Nm / 1915 lbft
12 AS 3002 TC	12	2700 Nm / 1990 lbft

### Spare parts supplies still available for:

HP 500	HP 600	HP 900
4 PW 95	4 PW 200	Brake systems



## Transmissions available for tracked vehicles

	Number of gears	Input torque [Nm] / [lbft]
LSG 300	4	280 Nm / 205 lbft
LSG 1000	6	1800 Nm / 1330 lbft
P 25000 (final drive)	ratio 4,67	25000 Nm / 18440 lbft

### Spare parts supplies still available for:

4 HP 250	LSG 1500	LSG 2000
LSG 3000	P 1700 (final drive)	Brake systems

### Illustration references:

KRAUSS-MAFFEI WEGMANN, MOWAG AG, Patria Vehicles Oy, RLS Landysteme, General Dynamics Santa Bárbara Sistemas GmbH, Flensburger Fahrzeugbau Gesellschaft mbH, Giat Industries, Alvis Hägglunds

