



The road to the future



Electronic systems for vehicles





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Accelerating progress in the automotive industry. As a partner for car manufacturers all over the world, for many years ZF has been pursuing the same objective: to increase the efficiency and cost effectiveness of individual mobility and transportation. Technical solutions in chassis and driveline technology rely increasingly heavily on electronics, with this field accounting for up to 90% of innovations on board vehicles. ZF's expertise in this area is pooled in the Electronic Systems business unit, where it is used to support the entire ZF product range in order to improve vehicle efficiency.

Shifting to success. And making real progress.

Each year, ZF supplies renowned car manufacturers all over the world with some 4.4 million gearshift systems – whether for automatic or manual transmission – for passenger cars and commercial vehicles. In addition to focusing on technological innovation, we also prioritize sustainability and low environmental impact when developing our components.

With more than 50 years of development and production experience, ZF is a reliable supplier of systems and components to the automotive industry. Customers who purchase our gearshift systems enjoy the substantial benefits of the potential we can offer. We also work in close cooperation with the ZF passenger car driveline techno-

logy division in order to ensure that each and every customer can take advantage of perfectly coordinated gearshift and transmission systems from a single supplier. The future sustainability and ease of assembly of our gearshift systems come as standard, thanks to our exacting quality requirements: at ZF, we demand top quality every step of the way, from the initial solution proposal right through to the final test phase. And, at ZF, this quality can be guaranteed as we are responsible for the entire development process.

Gearshift bezel and root wood knob



Shift-by-wire gearshift for automatic transmissions



Taking the lead with shift-by-wire

Thanks to our specialist know-how and innovative thinking, we have established ourselves as the world leader for shift-by-wire gearshift systems for automated manual transmissions, and we have also secured a leading position in Europe in the entire automatic segment. The shift-by-wire gearshifts manufactured by ZF offer a range of benefits from optimal functional safety and ease of use to a variety of integration options in either the center console or the dashboard. Our cable gearshifts for manual transmissions also offer special advantages thanks to their exceptionally low vibration and noise transmissions.

Every project is different

However, regardless of which gearshift system we produce for our customers, our ultimate objective is always the same: to create the perfect combination of advanced technology and contemporary design. It is this objective that enables us to devise innovative solutions to individual customer requirements time and time again.

Our performance spectrum of gearshift systems at a glance:
Shift-by-wire gearshifts for automatic transmissions (Shifttronic)



Shift-by-wire gearshifts for automated manual transmissions



Cable gearshifts for automatic transmissions with electronic manual mode (Tiptronic gearshift system)



Cable gearshifts for manual transmissions



Controlling electrical systems to suit requirements

As the number of electrical systems rises, so too does the demand for more controls in the car. From seat adjustment and keyless entry systems to electronic damper systems, all electrical systems with a certain basic complexity require controls.

Enhanced interior comfort

The use of electronics is no longer confined to the instrument panel – electronics now play a key role in interior comfort too. Whether they are for electrically adjusting steering columns or seats, electronic systems are responsible for an ever-increasing number of functions designed for increased comfort and safety. An electrically adjustable steering column enables the driver to get in and out of the vehicle with greater ease. Both the steering column and the

driver's seat can be adjusted to the desired position by means of driver recognition or memory position systems. Seat height adjustment for the driver is even possible in construction vehicles, thereby ensuring enhanced driver comfort.

Modular control units for automated manual transmissions and hybrid transmissions

The “brain” in the automated drive-train is the transmission control unit. It determines which gear is



engaged, thereby also directly controlling the engine speed. Thanks to a modular system, it is now possible to use virtually the same control units for hybrid versions as those used for “conventional” automatic transmissions: the TCU (Transmission Control Unit) basic module is upgraded to the HCU (Hybrid Control Unit). The module contains both the control hardware and software. The design of the control unit therefore allows for the flexible addition of the power output stages for the relevant drive mode. This also produces the main benefit for the OEM: vehicle platforms with conventional driveline systems can also be designed as hybrid versions without any awkward changes to the control architecture. This offers the additional significant advantage of lowering the investment costs associated with supplying hybrid systems.

Design determined by use

Depending on the area of use, controls for electrical systems can be designed as either a decentralized unit or as part of a larger central control module. When more complex functions or functions relating to safety are involved, software development in accordance with Automotive SPICE is essential in order to guarantee a high level of product quality.

Transmission control unit for automatic transmissions



A selection of our control systems and electronic assemblies:
Transmission control unit for automated manual transmissions



Electronics for keyless entry system



Steering column electronics



Control unit for electronic chassis



Energy on board

The successful use of hybrid systems does not just mean that there is sufficient electrical energy available for locomotion. The on-board system also requires a permanent and adequate supply of energy. In order to ensure this supply, either an available generator is used or the function is integrated into the system architecture via a suitable on-board transformer.

Control and integration into the operating strategy and energy management of the vehicle take place via, for example, a CAN bus. As a “one-stop supplier”, we are able to offer our customers the added value that comes with our modular system: your own systems can be optimally integrated into this environment. The standardized system design also speeds up the process of designing and developing different versions.

Passenger car inverter



Commercial vehicle
DC/DC converter



Electric motor for
passenger car



Switching to safety – component by component

Quality and safety in production on the one hand, and, on the other hand, quality that offers drivers an enhanced level of safety as they negotiate traffic every day. ZF helps to improve safety by developing reliable components that meet the most exacting of standards. Because we know that it is essential for products to function reliably over the long-term and, sometimes, in the most adverse conditions.

Functions that guarantee safety

Driver safety begins with intuitive, easy-to-use control units, e.g. for seat adjustment or automatic transmission. It also includes solutions for monitoring seatbelts, tailgates and doors and extends to many other

features, such as steering column locks, gear shift gates or immobilizers, brake assistant systems, brake light switches and position indicators. Switches and the more complex product solutions based on them are primarily used for detecting position information. These then switch signal or motor currents.

Component carrier for side door latches with wet and dry area connector



Always in the correct position

Reliable position information detection by means of miniature switches are a key area of our expertise. From standardized single switches and pre-assembled solutions with cable harness and connector, right through to customer-specific component carriers – these functional modules fulfill all complex requirements.

The knowledge that you are in safe hands

At ZF Electronic Systems, we apply our expertise to a wide variety of different areas in order to promote driver safety. Only a tiny minority of our solutions are provided “off the peg”. In the vast majority of cases, we develop and adapt these solutions to suit the specific environments of new car designs, and in close cooperation with the automotive industry and its suppliers. The result is a wide range of solutions that blend seamlessly and harmoniously into the overall design of the modern vehicle.

A selection of our applications for switches and switch assemblies:
Brake assistant



Control module for additional heating or flap positions in ventilation systems



Touch control module, shift lock for automatic transmissions



Component carrier with insert molded stamping grid for the three-dimensional configuration of micro-switches on the trunk lock cylinder



Three-dimensional stamping grid as component carrier in the side door latch



Component carrier for side door latch with sensors



Moving into the fast lane, thanks to innovation

Thanks to our innovative developments, we are constantly helping to reduce the environmental impact of cars. Such developments include, for example, components for the driveline. These components make it possible to construct cars that are lighter in weight, thereby reducing both fuel consumption and CO₂ emissions.

The main innovative direction that we are currently taking at ZF Electronic Systems is one that is very important for the future of the car: sensor technology, especially for the driveline.

Sensor technology is the key

Whether for manual or automatic transmission, steering, the brake or the clutch: in order to reduce weight in the vehicle, mechatronic solutions are in particularly high demand. Such solutions require advanced modules with highly sensitive yet robust sensors that can function reliably for many years. Sensors are used in various different locations where non-contact measurement or a diagnostic switching solution is required. The components enable the non-contact retrieval of information relating to direction, angle, position, speed

Sensor cluster in 7-speed dual clutch transmission

Comprises four inductive sensors for directly detecting the shift fork position in the transmission, two speed sensors and a temperature sensor. Operation under adverse ambient conditions in an oil environment at temperatures of up to 150 °C.



and other physical parameters. They play a key role in enhancing the safety and efficiency of the mobility solutions of the future. In addition to enabling the measurement or switching function itself, it is also important that these sensors are integrated into a defined functional area, so that they can fulfill the specific environmental conditions of the application. It is only through precise knowledge of the state of all of the components in a vehicle system that the driver can be provided with maximum support and that the optimal efficiency of the vehicle can be achieved.

Example of a sensor technology application:
Neutral position sensor for start-stop request



Sensor cluster for automatic transmissions



Inductive selector lever module detecting the selector lever position in the gearshift lever housing of automatic transmissions



Sensor subassembly as brake light switch



Sensor package for brake assistant



Non-contact sensor for measuring wear in commercial vehicle braking systems



Research and development

Innovations are not a purpose in themselves for ZF; they must pay off, for manufacturers, fleet owners, and drivers, but also for the environment and society. Each new development must prove itself among the conflicting priorities of these criteria.

The ZF Group benefits from an international network of development centers: the main development locations are Friedrichshafen, Dielingen, Passau, Schweinfurt, Schwäbisch Gmünd (Germany), Northville near Detroit (USA), Pilsen (Czech Republic), and Shanghai (China). Worldwide, approximately 5,400 engineers work in Research and Development. Corporate R&D coordinates and supports the activities at the development center in Tokyo (Japan). Every year, ZF invests approximately five percent of its sales in Research and Development. With success, because innovative products from ZF set the standards for state-of-the-art technology – again and again.

Development work at ZF is organized according to decentralized and central functions. The divisions and business units focus on markets and product expertise, ensuring customer-centered, competitive technological product development. Corporate R&D works with a strong emphasis on basic research and theory and supports the functional development areas in the divisions.



An innovative approach to development

Regardless of whether our objective is to shorten development times, to increase the efficiency of manufacturing processes, to use materials more sparingly or to find and test new materials, one thing is always the same: we do not miss any opportunity to make our development processes environmentally friendly and economical. Every detail of our electronic components is scrutinized before they enter into manufacture. This greatly reduces the length of time required prior to readiness for the start of mass production and also has the major benefit of keeping development costs low. The bottom line is

that we can honestly say that we have no qualms about allowing any product we have manufactured onto the road.

Comprehensive testing

Our new developments in particular must pass various tests in order to demonstrate that they offer both reliability and a long serviceable life. At ZF Electronic Systems, we therefore have specialist test centers where we perform a wide range of fundamental tests on components and materials, as well as measurements during the development stage and tests on completed products.



- 1 3D design on CAD workstation
- 2 Computer-aided layout development
- 3 Magnetic field simulation for sensor magnet configuration

Producing quality. And putting quality products on the road.

We take pride in the fact that each part we produce is identical to the next, right down to the last detail; that we can make the same part a hundred thousand times without the slightest discrepancy. This may sound dull, but it is a hallmark of our high quality standards.

Walking through our production halls is like walking through an exhibition of the very latest production processes. And that is how it should be: only these modern processes can guarantee absolute top quality – the kind of quality that technology simply has to provide when it is going to be used on roads all over the world. Only impeccably functioning components will benefit both safety and the environment. For example, the latest generation of SMD high performance placers can place even fine pitch components onto the component carriers with exact precision. We also offer technologies such as chip-on-board. When it comes to conventional, wired components, we use wave soldering systems; the use of nitrogen allows for an extremely high soldering quality. 100% functional tests, visual inspections, in-circuit tests, unique injection molding and casting expertise – and much, much more.

Production characterized by quality

It is, however, also important that we use flexible manufacturing concepts – from modular assembly to highly automated production lines – so that we can offer top quality at an affordable price. It is also vital for our staff to use their own initiative and demonstrate a high level of commitment in order to optimize processes and take every possible step to ensure genuine quality. ZF customers can rely on up to 100% end of line testing, including complete traceability of all manufactured systems. Our subassemblies and products must meet every aspect of our very exacting standards in a wide range of tests before we let them out onto the roads – all in the interests of the environment, safety and economic driving performance.

Hardness test for components

No matter which component or which system is being tested, conventional tests do not meet our exacting requirements. We perform tests under conditions that are more extreme than the toughest of external conditions. We also simulate time periods that extend far beyond the expected lifespan of a vehicle. We believe this is essential when safety and reliability are at stake. We accept no compromises. One critical factor in this age of electronics is electromagnetic compatibility. There are two important concerns here: firstly, that there is no adverse effect on equipment and functions and that they are afforded sufficient protection and, secondly, that equipment and systems do not transmit any interference waves that could have an adverse effect on other equipment or systems.



Environmental simulation

Environmental simulation is another key focus. We conduct functional tests in heat and bitterly cold temperatures, in wet, foggy and salt spray fog conditions, as well as tests that involve jolting, shaking, bumping, strain, warping or pressure. Only components that pass our entire range of tests with flying colors will enter into mass production.

Our test procedures at a glance

Environmental simulation

Functional tests and serviceable life tests under conditions involving heat, cold, damp, corrosive atmospheres such as SO₂, salt spray fog, oil. ■ Vibration / shock tests • Leak tests • Acoustic measurements ■ Haptic tests ■ Illumination tests ■ Surface tests

Electromagnetic compatibility (EMC)

ESD, burst and surge tests ■ Simulation of network anomalies, e.g. spikes ■ Motor vehicle impulse testing ■ System testing in the black box test using control units and intelligent sensors

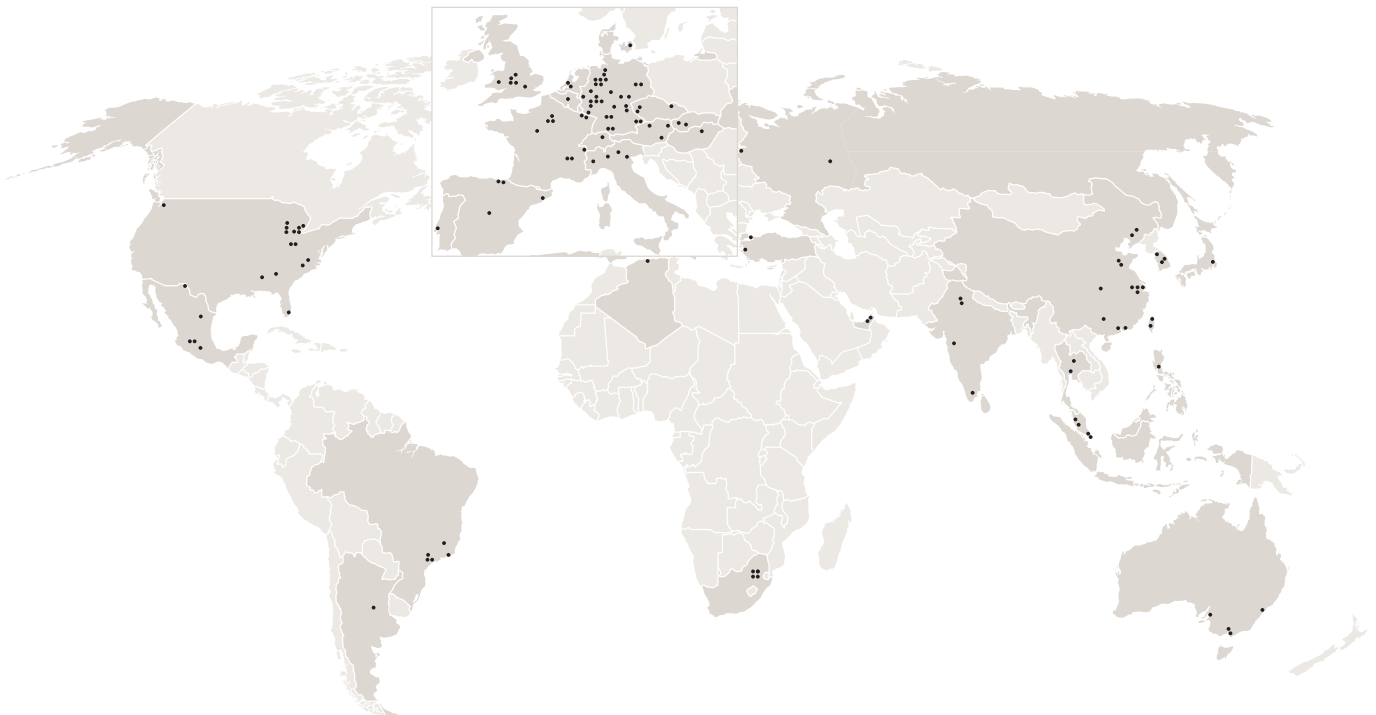


The ZF Group at a glance

Worldwide, the ZF Group has 117 production companies and 8 main development locations in 26 countries. In addition, we have approx. 34 service companies and representative offices as well as 650 service partners. This enables ZF to provide a tight network of highly qualified contacts close to international customers at all levels and in all regions.

ZF is consistently expanding its global market presence. Both established market regions and new markets play very important roles. Particularly activities outside Europe will gain more importance in the future. This applies not only to the established markets in North and South America, but especially to the Asia-Pacific region and the new markets in Eastern Europe and India. Key aspects here are market

development through adapting products to specific market requirements and best-cost-country considerations which play a decisive role in production and procurement. ZF supports the international expansion of established customers while also adding partners from new market regions to its customer portfolio.





Driveline and Chassis Technology

Powertrain Technology

Transmissions

Axle Drives

Powertrain Modules

Chassis Technology

Chassis Systems

Chassis Components

Rubber & Plastics

Suspension Technology

CV Technology

Truck & Van Driveline Technology

Bus Driveline Technology

CV Axle Systems

CV Chassis Modules

CV Damper Technology

CV Powertrain Modules

Industrial Technology

Construction Machinery Systems

Agricultural Machinery Systems

Material Handling Systems

Test Systems

Special Driveline Technology

Electronic Systems

Marine Propulsion Systems

Aviation Technology

Wind Power Technology

Steering Systems



Passenger Car Steering Systems

Commercial Vehicle Steering Systems

Passenger Car Steering Columns

Global Aftermarket

ZF Lenksysteme GmbH is a joint venture of ZF Friedrichshafen AG and Robert Bosch GmbH.

Brands of ZF



ZF Services

We develop and manufacture innovative, high-quality products and related technologies that improve the mobility of people and goods. Our products and services offer our customers clear added value

through leading technologies, quality, and service. Our passionate commitment to achieving greater efficiency and resource conservation has made us a trendsetter in new markets.

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