On Tour

Driveline Technology
In Modern Buses
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We are living in the era of global mobility, we are on tour worldwide. In everyday business or in our leisure time - never before have people experienced such a high level of mobility as today. Due to the constantly increasing traffic density in metropolises and megalopolises, public transport with buses in particular is gaining importance. Above all in Asia and South America, more and more people have to be transported in shorter intervals. Therefore, the "Bus Rapid Transit" concept is becoming increasingly popular; this is where buses can avoid the congestion in individual traffic because they operate on lanes of their own.

The demand for alternative drive concepts, particularly hybrid solutions, is meanwhile also put forward by the BRIC states and goes beyond the current offer.

The Bus Driveline Technology business unit of ZF Friedrichshafen aims at making buses a more attractive option. We already include the operators’ economic considerations in the early stage of development. Both small and large fleets benefit from considerable fuel savings, reduced maintenance effort, and the long service lives of our products. The fact that also pollutant and noise emissions are kept at a low level make riding a bus equipped with a ZF transmission even more pleasant for drivers, passengers, and pedestrians. Special driveline concepts make it easier for bus companies and city planners to use the vehicles in “Bus Rapid Transit”.

In addition to efficiency, safety, and comfort, increasing priority is given to ecology. Innovative concepts such as hybrid drives or electric drives are almost ready for production. We are excited about being on tour!

Wolfgang Schilha

“Bus transmissions have long become an important economic factor for operators and help them ensure that their vehicles meet ecological requirements which are becoming ever more stringent. Whether in city traffic, suburban traffic, or in coaches, ZF bus transmissions allow for economical and environmentally friendly operation in all applications.”

Wolfgang Schilha, Senior Vice President of the Bus Driveline Technology business unit
It would be impossible to imagine our cities without different kinds of public transportation. City buses play an important role in this context. They allow for precise connections from one point to another. From your apartment to school, from work to the grocery store. They provide people with mobility in their everyday lives. They provide relief for city streets. And they protect the environment.
Modern Driveline and Chassis Technology from ZF allows for quick passenger transport in the megacities of our world by means of the “Bus Rapid Transit” (BRT) lines. Automatic transmissions increase road safety by relieving bus drivers from clutch operation and gearshifts on increasingly crowded roads. Innovative hybrid drive concepts make a contribution to reducing CO₂, particulate matter, and noise emissions in metropolitan areas. Buses driven by hybrid technology consume considerably less fuel which, in turn, makes it much easier for transport authorities to drive economically.
Bus Rapid Transit: Driveline and Chassis Technology for Low-Floor Buses

Metropolises in South America and Asia are growing unexpectedly fast. The result are congested roads, traffic jams, and smog. In order to avoid a collapse, individual traffic has to be reduced and public transit must transport more and more people in ever shorter cycles. Transport authorities and city planners increasingly bank on “Bus Rapid Transit” (BRT). With ZF’s low-floor concept, BRT can be implemented quickly and efficiently without long lead times.
In order to cope with the growing number of passengers in megacities, line traffic must be sped up and transport times shortened. The BRT solution: separate bus lanes and the reduction of dwell times at bus stops to a minimum – by “pre-board ticketing” and barrier-free, controlled boarding and exiting. Vehicles equipped with ZF low-floor technology allow for “one level boarding”, i.e. level entry and exit to ensure quick passenger flow without platforms or steps inside the bus. In Beijing, dwell times of just 16 seconds have been achieved as a result. There, buses have a 50 seconds cycle during rush hour.

The advantages of BRT low-floor concepts compared to platform concepts or rail-based solutions: They can be implemented quickly, without time- and planning-intensive building activities and with a reasonable investment volume. Little space is required at bus stops. Both the routing of the buses and the number and position of bus stops can be changed flexibly at any time. Furthermore, at the same bus stop level, it is possible to change over from shuttle buses to buses running on the BRT line.

As a systems supplier, ZF offers complete front and rear axle systems. In case of the rear axles, the driven AV 132 portal axle ensures the consistent low-floor design of the vehicle. The ideal supplement at the driveline end are the Ecomat and EcoLife 6-speed automatic transmissions. They guarantee a high level of driving comfort as well as easy handling, and they reduce fuel consumption and pollutant emissions.

- Quick implementation without large-scale, costly infrastructure
- Low-floor design of the entire vehicle
- Reduction of stopping times
- Increase of route-based average speed
- Reduction of fuel consumption and pollutant emissions when combined with Ecomat and EcoLife
Ecomat Automatic Transmission: Driveline Technology in City Buses

It is the job of the city bus driver to make the journey fast and yet comfortable. On the one hand, ZF transmissions and driveline components provide for dynamic acceleration, smooth gearshifts, and very quiet running. On the other hand, with their high reliability and ease of operation, the driver can completely focus on the road. The Ecomat 6-speed automatic transmission is a good example. Supplementary to low-floor technology it is also ideally suited for “Bus Rapid Transit” systems.
6 in the city. Featuring six gears, the current Ecomat automatic transmission not only contributes to optimizing vehicle handling and efficiency but also generates considerable fuel savings and reduced pollutant emissions. CAN technology makes communication with modern EDC engines possible. With the "Neutral Bus Stop" function, fuel consumption can be further reduced. Moreover, the Ecomat with its six gears is perfectly adapted to frequent starting processes in city bus applications. A special torsional damper not only ensures further fuel savings, but also preserves the driveline and contributes to the minimization of vibrations. The use of the especially fine-tuned Ecofluid A plus transmission fluid increases the maintenance intervals: Oil changes are only necessary every 150,000 kilometers (93,206 miles), and the overall service life of the transmission is extended.

The transmissions in the Ecomat series have a unique integrated primary retarder. It slows the vehicle down in any situation, gently, smoothly, and powerfully - even in the lowest gears. The retarder is integrated into the brake management system via CAN communication. Braking is coordinated with the engine and service brakes, and the retarder is ABS-capable.

- Six gear steps
- Rapid lockup torque converter for starting
- Integrated primary retarder
- Dynamic, topography-dependent drive program selection with TopoDyn

For further information visit: http://www.zf.com/products/ecomat
EcoLife –
The Economic Breakthrough
Changed requirements in public transport, growing competition, and rising fuel prices continually require new ways of thinking in the field of bus driveline technology. More and more people are to be transported in increasingly shorter times. City buses become larger, vehicle combination weights higher, engines more powerful. The suitable ZF automatic transmission EcoLife has proved to be successful in various applications. The 6-speed transmission can transfer torques of up to 2,000 newton meters (1480 lb/ft) and resists also operating temperatures of modern Euro 5 engines or future engine generations. Ideal for transport operators: With increased vehicle power, fuel economy even exceeds all expectations. This savings effect is further intensified by TopoDyn, particularly in the case of bus lines with varied topography. During travel, the integrated standard drive program changes between the respectively most economical shift strategies, depending on the topography and driving resistance.

**ZF sets new standards with EcoLife:**
- Completely new 6-speed automatic transmission
- Better economy and ecology
- Ideal for new engines and emission standards (EEV, EPA10, Euro 6, ...)
- Better performance characteristics (up to 2000 newton meters torque)
- Extended oil change intervals of 180,000 kilometers (111,847 miles) and more
- Longer service life
- Considerably reduced noise emission
- Integrated primary retarder (40 percent better braking performance)
- TopoDyn: dynamic drive program selection considering topography and driving resistance

In comparison to today’s powershift transmissions, EcoLife transfers 25 percent more torque and is designed for an extended service life. The newly developed and highly efficient dual cooling system easily copes with the up to 15 percent higher operating temperatures of modern engines. ZF developed the transmission fluid Ecofluid Life especially for these applications.

For further information visit: www.zf.com/products/ecolife
In volume production since 1980 and continuously improved, the automatic Ecomat transmission is firmly established on the international market. Just like the even more powerful successor EcoLife, it reliably supports bus drivers for passenger transports on all continents. City and regular service buses in particular, but also coaches are equipped with close-ratio planetary gear sets in a light metal alloy housing. These automatic transmissions are passenger-friendly and economical.
SBS transit in Singapore modernizes its bus fleet

SBS Transit in Singapore, one of the leading bus and rail operators in the region, has procured 1400 new buses with automatic ZF transmissions in the last three years. In addition to the Scania city buses equipped with 200 6-speed Ecomat transmissions, there were also 150 new EcoLife transmissions 6 AP 1403 B for the first time this year, installed in Volvo double-decker buses. By purchasing the 350 buses in 2010, the average age of the SBS-Transit bus fleet is reduced by three years to eight years.

EXPO visitors are transported with Ecomat and EcoLife

Approximately half of the new buses in the Bashi and Pudong fleets bought in the last two years by the city transport authorities in Shanghai for the Expo 2010 have automatic transmissions on board.

1221 Ecomat and 146 EcoLife transmissions in Sunwin/Volvo and in Wanxiang/Daewoo buses make sure that the inhabitants and trade show visitors reach their destinations safely and comfortably.

In Sardinia with EcoLife and a smart drive program

The city of Cagliari in Sardinia has replaced 70 percent of its fleet with new buses. From the 171 vehicles, twelve are equipped with Ecomat and 153 with EcoLife transmissions. For the transport company CTM, the first in Italy to use EcoLife transmissions with the intelligent drive program TopoDyn, this means fuel savings of 10 percent. This corresponds to EUR 500 000 per year with annual fuel expenses of EUR 5 million.
On uphill gradients, drivers choose high shift points, on level ground, they engage a higher gear earlier. Very often, buses equipped with traditional automatic transmissions cannot provide such flexibility. Even though several drive programs may be stored in the transmission electronics, it is only possible to activate one at a time during travel. This selection determines fuel consumption and is always a compromise when the topography is varied. City and intercity buses with TopoDyn are uncompromisingly economical. The flexible drive program which is available with an optional Ecomat version and a standard EcoLife version dynamically adjusts the shift strategy to the route during travel.

- Normal, Eco, and Power – these are the names of the standard drive programs which can be selected in accordance with the route profile. However, this can only be done before the bus starts moving, not during travel. For instance, if the rather flat route contains a short but steep uphill gradient, Power needs to be activated and must then be kept for the remaining route. This is everything but economical. TopoDyn makes this program selection for the manufacturers and operators. Depending on the terrain, it flexibly changes between the shift strategies Normal, Eco, and Power – with the Ecomat this happens according to defined, preset values, with the EcoLife in a continuous, variable, and thus even more efficient way. Therefore, the bus is operated most economically at any time and on any section of the route. Fuel savings: five to eight percent.

- The advantages of TopoDyn compared to similar GPS-based or sensor-assisted systems: It is easy to integrate, there are no additional components or electrical interfaces. The system also operates in areas where GPS is not available. TopoDyn works perfectly from the very first meter and does not need a “teaching-in” phase on new routes. Incidentally, TopoDyn Life also considers the driving and road resistance of buses in addition to the topography.
Operating Data Analysis and Testman pro: How to Become More Economical

How is it possible to reduce both fuel consumption and maintenance and repair costs? ZF helps vehicle owners and fleet operators increase the economy of their vehicles in both areas: by means of consumption-optimized operating data analysis and preventive diagnosis systems such as Testman pro.

The operating data analysis offered by ZF

Is the bus used on one route or on different routes? What about topography, the number of stops, and the average speed? By analyzing the operating data, ZF can optimally adapt vehicles to their field of application. Based on the performance parameters of previously used buses, the economical operating method of the driveline is optimized in the new vehicle by selecting a suitable engine and transmission design and rear-axle ratio. This reduces fuel consumption and extends the service life.

Testman pro

Highest possible planning and cost reliability, prevention of repairs and the related expensive, unscheduled downtimes. This is what Testman pro, the preventive service and maintenance product, aims at. The ZF diagnosis system determines all performance-relevant data while the bus is standing still or online while it is moving, thus making the transmission’s inner life transparent. Access is possible via PC, cell phone, or modem and can therefore take place worldwide. Based on this data, maintenance times can be planned exactly and failures can be detected before they have negative impacts.
City buses of the future are even faster, more comfortable, more environmentally friendly, and quieter. They run with innovative ZF hybrid technology. For frequent starting, braking, and acceleration which are so typical for city traffic, the parallel hybrid system made by ZF provides essential advantages. Fuel consumption, pollutant and noise emissions are reduced considerably. And there are no restrictions in terms of driving comfort either. ZF hybrid technology opens up new areas for fleet operators, even low-emission zones in downtown areas.
HyLife:
The hybrid transmission

- Based on the EcoLife 6-speed automatic transmission, ZF is developing a parallel hybrid system to specifically meet the requirements in modern public service buses. Among other things, the torque converter is replaced by a hybrid module which leads to attractive purchase prices and major fuel savings. As a full hybrid version with 120 kilowatt electric power, the hybrid transmission offers all functions: start-stop operation with shutdown of the combustion engine; electrically assisted acceleration (boosting); recuperation, i.e. charging of the hybrid batteries with recuperated braking energy; purely electric starting and driving.

- The compact system consisting of hybrid control unit, hybrid transmission, inverter, and batteries can be integrated at optimal cost into all existing and future vehicle designs. The required installation space is similar to that of the conventional EcoLife transmission. ZF supports the manufacturers with energy management during system integration.

- Considerably reduced fuel consumption
- Installation space similar to conventional EcoLife transmission
- Considerably reduced pollutant emissions
- Vehicle noise reduction
- Compact design
- High performance of the electric motor

HyTronic lite – Hybrid system based on the AS Tronic lite

- The hybrid system is based on the well-proven and applied AS Tronic lite transmission system which has been tried and tested in thousands of missions. The hybrid module’s compact design makes it much easier to integrate into existing vehicles. This is enabled by using a special electric motor with a capacity of up to 60 kilowatts for a torque of 500 newton meters (370 lb/ft) which is integrated in a space-saving manner. The engine connection including the dry clutch is identical to that of the basic transmission. The integrated water cooling system can be connected either to the vehicle cooling circuit or the ZF cooling system. The good drivability of an AS Tronic lite transmission is still ensured with the hybrid version due to the modular add-on control unit structure.

The serial hybrid approach: AVE 130 hybrid drive axle

- The serial hybrid solution, with the electric wheel hub drive directly mounted to the bus axle, is suitable for city bus concepts which have to meet particularly demanding noise quality and flexibility requirements. The installation space required deviates only slightly from that of standard portal axles in low-floor buses. Therefore, installing it as a central axle or as a rear axle in articulated buses is possible without complicated, expensive adjustment of the chassis.
AS Tronic lite Automatic Transmission System: Driveline Technology in Light City Buses and Coaches

The world is moving. In Eastern Europe, Asia, Latin America, and Africa, metropolises are emerging and growing fast in some places. Traffic density is enormous, passenger transport requirements are rising. However, except for vehicles running in inner city “Bus Rapid Transit” lines, many light buses used as shuttle or feeder buses are still equipped with manual transmissions. Their automation can significantly increase safety, comfort, and economy. The new AS Tronic lite represents the financially viable option of using an automated transmission even for operators with limited resources.
The new AS Tronic lite is an automatic transmission system with six gears for micro, mini, midi, or light city buses. In the automatic mode, the transmission’s electronic control unit, which is connected to the engine via CAN, selects the gears. It is possible at any time to switch to manual gear selection. The electrohydraulically shifting transmission with a space-saving modular design is suitable for buses with a total weight between 9 and 18 tons and for engines with an input torque of up to 1050 newton meters (770lb/ft).

Relieved of clutch and shift work, the driver can fully concentrate on traffic. The automatic transmission system is easy to operate, the shift quality is consistently high even in the case of frequent driver changes or novice drivers. Incorrect shifting is excluded. Short shifting times ensure the dynamic performance needed for acceleration. Safety comes hand in hand with a high level of economy. In comparison to manual transmissions, five to ten percent fuel can be saved.

In the future, the automatic AS Tronic mid transmission system will bridge the gap in the torque range between AS Tronic lite and AS Tronic. The modular transmissions cover the torque range up to 1600 newton meters (1180 lb/ft) and are based on the manual EcoShift transmission range.

- Optional: manual or automatic shifting
- Reliable and service-friendly thanks to modular design
- Reduced operating costs: fuel consumption, clutch wear

For further information visit: www.zf.com/products/astroniclitebus
Coaches are a good alternative both to other means of transportation and to individual traffic. Regardless of where the journey takes you: to a concert, a sports match, sightseeing, an international trade show, or on vacation, regardless of whether the destination is domestic or abroad. Coaches are becoming more and more attractive.

Arriving Relaxed: With Coaches to Remote Destinations
AS Tronic Automatic Transmission System: Driveline Technology in Coaches

“Reclining seats, air conditioning, AS Tronic.” This is how a bus company describes the carefree trips on its buses. A transmission playing a role in comfort? As a special option? You bet. From the very beginning, when drawing up the technical specifications for the AS Tronic, passenger comfort was taken into consideration. Clutch operation and shifting happen smoothly and automatically. This contributes both to increasing passengers’ well-being and to relieving the bus driver. Furthermore, AS Tronic provides a choice for the bus driver – at the push of a button he can switch anytime from automatic to manual mode and vice versa.

- The AS Tronic combines tried and trusted ZF technology with modern electronics and was specifically designed for buses with EDC engines and CAN communication. The control unit of the 12-speed automatic transmission provides for optimally coordinated shifting and clutch work. Perfect communication between engine, clutch, and transmission protects the entire driveline – both when maneuvering at crawling speed and on the road. Incorrect shifting is excluded.

- Due to the high number of closely stepped gears, the engine always operates in the most economical range. In addition, the integrated retarder allows for safe, fading-free deceleration and preserves the brakes. So the AS Tronic provides for more safety on the road and for more efficiency in companies. Reduced fuel consumption, less wear, and minimum maintenance efforts help save costs.

- All main transmission components are integrated into the housing. The modular design simplifies installation and maintenance and provides optimum protection from outside influences.
- No "added on" control elements
- Only few central connections for compressed air and electrics
- Electronic control unit (ECU) integrated into the shift module
- Integrated secondary retarder (Intarder)
- More simple, shorter, lighter, and more universal than anything else currently offered on the market

For further information visit: www.zf.com/products/astroniccoach
AS Tronic: Reliable, Proven, Efficient

For many years, the AS Tronic has been a reliable companion on interurban trips. With this automatic transmission system, bus drivers bring their passengers safely and comfortably to their destinations. Everywhere in the world and always with a convincing cost-performance ratio.
AS Tronic is convincing in terms of consumption and comfort

- **ALSA** is Spain’s leading private bus company. It operates more than 2300 buses in Spain, 1400 of which are intercity buses. Since 2003, ZF-AS Tronic is the first choice for transmissions. 480 buses are therefore equipped with ZF’s automated transmission. “We are absolutely convinced of AS Tronic”, explains Victor López Menéndez, general maintenance director at ALSA, “because it reduces fuel consumption”.

- Artists and their crews choose the exclusively equipped buses from the North Rhine-Westphalian Coach Service GmbH when they go on tour across Europe. Chris Hahne, managing partner of the company states: “Since we’ve been using AS Tronic transmissions in our buses, shifting comfort has noticeably increased for our drivers. Naturally, the passengers also notice that the drivers are more relaxed even after several hours of driving. Beyond that, the transmissions are very reliable and whenever we need the ZF service, we have friendly and highly qualified contacts at the service center in Dortmund.”
Ultramodern synchromesh technology with power assistance ensures that the bus gets off to a good start. Helical gears provide for quiet running.

To operate the transmission, you can choose between a traditional shifting system or durable, maximum-precision ZF link bracket/gearshift linkage. The Servoshift further reduces shifting force and travel. The option of integrating the Intarder* with its heat exchanger leads to additional safety.

*not for Ecolite transmissions

EcoShift: ZF’s new manual bus transmissions. The 6-speed transmission range was developed for the torque range between 1000 and 2100 newton meters (738 and 1550 lb/ft). What makes it so special: The basic version is a flexible, modular platform which can be extended, among other things with the new Intarder generation from ZF and up to 1600 newton meters (1181 lb/ft) with a module for automated clutch actuation and shifting. This means that altogether seven transmission variants are possible. EcoShift is ready to meet future market requirements by offering improved efficiency, even lower shift forces, less noise, and a more robust housing.
Six gear steps
Advantageous dimensions, low weight
Secondary retarder (Intarder) can be integrated

For further information visit: www.zf.com/products/synchrotransmissionbus
The latest version of the ZF transmission brake generates an up to 25 percent higher braking torque but weighs less, operates much quieter, and is more environmentally friendly than its predecessor. The braking power of the Power version equals 4000 newton meters (2960 lb/ft), the Eco version’s 3300 newton meters (2440 lb/ft). Thanks to the reduced number of interfaces, the Intarder is easy to connect to the transmission system and just as easy to install in the vehicle. The electronic control unit allows for optimum integration into the vehicle brake management – including cruise control function.

Due to its integrated oil circuit, the Intarder can also be used for transmission cooling and heating functions. Thanks to its active support, the required transmission fluid temperature – and thus also the optimum efficiency for fuel consumption – is reached much faster.

The new Intarder is more powerful but still quiet. Thanks to reduced brake wear, brake dust pollution is decreased. These are aspects which are of benefit to the environment and reduce operating and maintenance costs at the same time.
The Intarder is available for manual ZF synchromesh transmissions and AS Tronic automatic transmission systems.

- Hydrodynamic, wear-free hydraulic retarder
- Braking is independent of engine speed
- No interruption in brake force while shifting or operating the clutch

For further information visit: www.zf.com/products/intardercoach
With more than 700 service centers worldwide, ZF is always nearby when drivers, owners, or fleet operators of vehicles equipped with ZF driveline technology need professional support. Depending on the customer requirements, either spontaneously as needed or preventively following a schedule. Customized maintenance, repair and service packages with extended warranties make cost and planning more reliable for customers and – if there is a failure – ensure that the fleet continues to run reliably by providing replacement units.
ZF products offer a plus in performance, economy, and reliability. Calculable and thus secured operating costs represent another advantage of the new service concept called ZF-Plus. Already when making the purchasing decision, ZF-Plus offers forwarders, fleet operators, and vehicle owners cost transparency in terms of repair, maintenance, fleet service, training and consulting - upon request even for the entire service life. Different service packages for each field make it possible to adjust ZF-Plus to the specific service needs of a fleet. And all of that with a fixed price guarantee. No matter where our customers are operating worldwide.