

The new generation of automotive powertrains

More comfort with less fuel

Modern dual-clutch transmission (DCT) technology provides an excellent balance between driving comfort and fuel efficiency. To date, 90% of all the synchronizers built for DCTs, feature Sulzer friction and component technology.

The reduction of CO₂ emissions is one of the most important goals in the development of modern automobiles. The focus on emissions is driven by government regulations on the one hand, and by the growing consumer demand for environmentally friendly technologies on the other. The limits on vehicle emissions, which mainly relate to CO₂ and particle levels, are expected to be tightened every five years. The increasing demand for green technologies also reflects the financial impact experienced by motorists who use non-fuel efficient vehicles as well as the higher re-sale value of low emission models.

Today's transmission technologies

Automatic transmissions (AT) and continuous variable transmissions (CVT) offer excellent driving comfort compared to manual transmissions (MT), but also higher fuel consumption. Automated manual transmission (AMT) technology offers a very good level of fuel efficiency, but its reduced driving comfort limits its scope of application. New generation transmissions, known as dual-clutch transmissions (DCT), provide a good compromise between driving comfort and fuel efficiency. [1]

The dual-clutch transmission

DCTs are basically a combination of two manual transmissions within one gearbox, with separate clutches for odd and even gears. The engine torque is transferred continuously between the clutches. The torque flow from the engine to the wheels is not interrupted during gear changes, unlike that of MTs and AMTs.

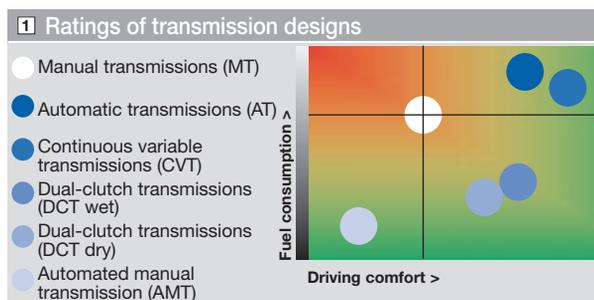
Since drivers cannot physically handle two clutches, the gear change is operated and controlled by the transmission control unit. From the drivers' perspective, a DCT performs in the same way as an AT.

The first actual DCTs appeared in the 1980s. The "Porsche Doppelkupplung" (PDK®) was used in the Porsche 956, the 962 Le Mans, and the Sport Quattro S1 race car. Today, the Volkswagen Group is just one of a number of car manufacturers that sell DCTs. The transmissions supplied for Volkswagen, Seat, Škoda, and Bugatti vehicles are marketed under the brand name "DSG Direct-ShiftGearbox (DSG)" and the transmissions for Audi are marketed under the name "S-Tronic". Other independent transmission manufacturers like Getrag and ZF have developed a range of DCTs, including a seven-speed unit for mid-engine longitudinal applications, which are capable of managing more than 750 Nm of torque. The BMW Z4 roadster that will be unveiled in May 2009 will be one of the newest models to feature a DCT.

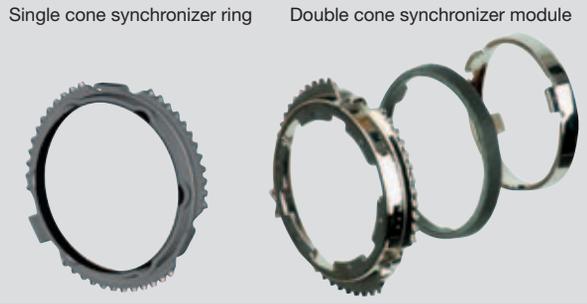
Efficient synchronizer technology

Although a DCT performs in the same way as an AT, synchronizers are still needed to select the gears.

Synchronizers are designed to synchronize the rotational speeds of the gearwheel and shaft through friction before the dog clutch is engaged. [2]



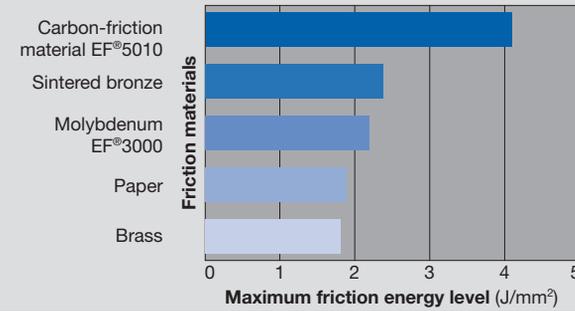
2 Synchronizer technology



While the main requirement for MT synchronizers is good shift quality, DCT synchronizers focus on providing a high load capacity. Both requirements can be met by high-performance stamped steel synchronizers with an EF[®]5010 friction lining. The favorable friction qualities of the lining meet the needs of MTs. The superior energy and power density of the

friction material, and the strength and durability of the steel satisfy the DCT requirements. Consequently, Sulzer synchronizer technology facilitates the multiple use of the same synchronizer design in DCTs as well as MTs and enables a modular system to be developed that serves different applications with identical synchronizers. [3]

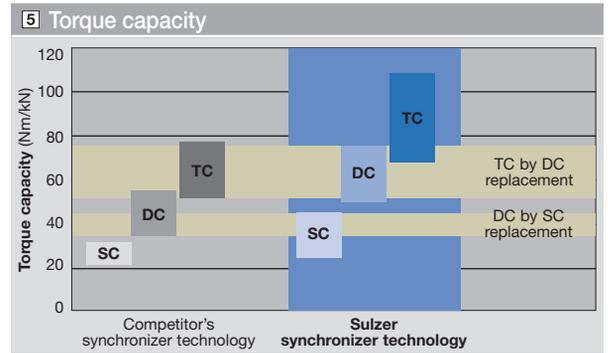
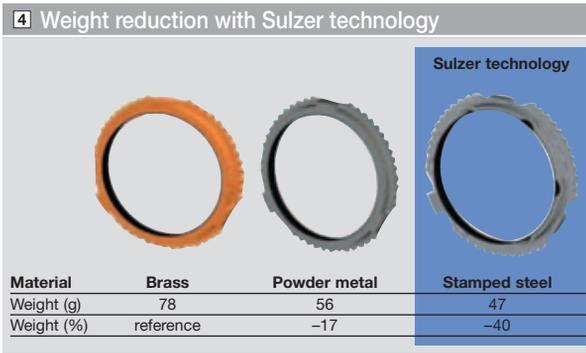
3 Materials performance



Sulzer synchronizer technology also facilitates weight reduction, which has positive impact on CO₂ emissions. Weight and inertia can be reduced by approx. 40% compared to brass synchronizers, and by 17% compared to powder metal technology. An overall reduction of up to 250 grams can be achieved by applying this technology. Due to component



The new Škoda Superb is available with a DSG-transmission.



weight reduction, it is possible to reduce the total gearbox weight by 600 grams [4]. This appears to be a small reduction compared to the gross weight of a vehicle, but ambitious targets can only be realized through a number of small steps.

Synchronizers can be designed as single, double or triple cone synchronizers, depending on the required synchronizer torque. Using the higher coefficient of friction of EF®5010 materials, Sulzer synchronizer technology provides a higher torque capacity than its competitors [5]. If double-cone synchronizers (DC) are replaced with advanced Sulzer single-cone synchronizers (SC), both shift quality and gearbox performance will be improved. The reduction of the number of components from three to one leads to significant cost savings as a result of the use of stamped steel synchronizers with EF®5010.

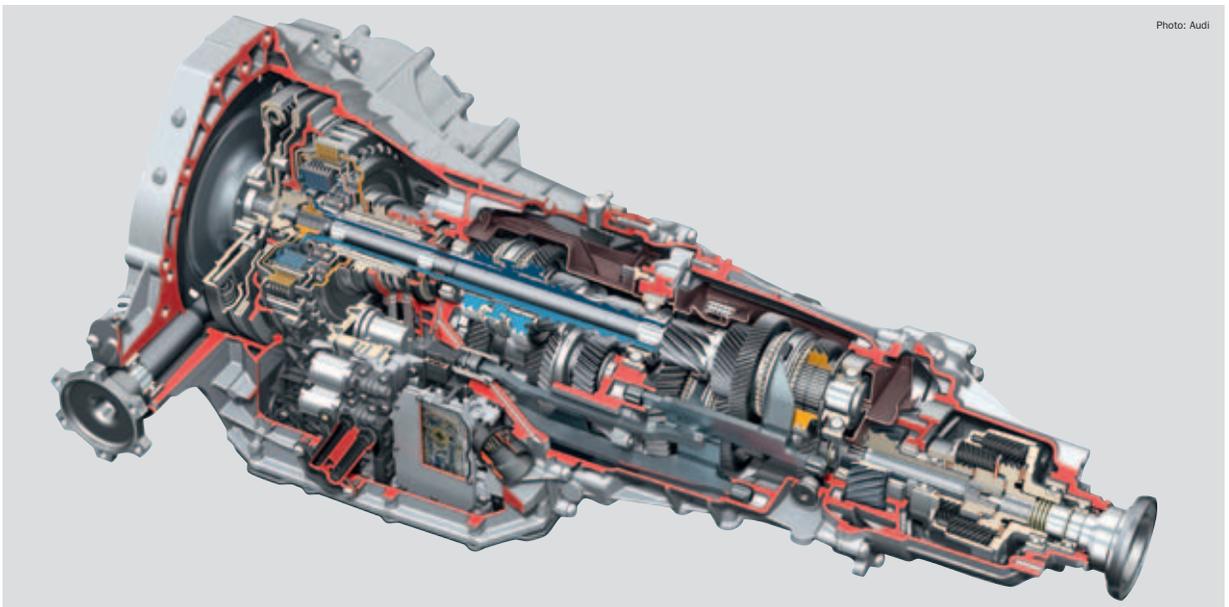


The new BMW Z4 sDrive35i is optionally equipped with a 7-speed sport dual-clutch transmission.

Furthermore, Sulzer synchronizers provide car manufacturers with greater flexibility when selecting the best oil for their systems. Carbon friction material EF®5010 is already approved for most

types of oil such as manual transmission fluid (MTF), automatic transmission fluid (ATF) and transaxle fluid. The insensitivity of the carbon material to oil additives means that the composition of

"Audi S Tronic 7"-speed dual clutch transmission.



The quality of longevity

the transmission fluid can be tailored to the requirements of the clutch and other components. This may eliminate the current need to change a vehicle's transmission fluid after half of its lifetime and thus generate direct financial benefits for car owners.

A good response within the industry

In 2009, it is expected that the demand for DCT synchronizers exceed 3,000,000 units. Nearly 90% of these synchronizer components will feature Sulzer's well-known EF®5010 and EF®3000 friction materials. This level of success is attributable to Sulzer's involvement in the development process from the very start and has therefore facilitated the best solution for each application. Major car manufacturers such as Audi, BMW, Bugatti, Porsche, Seat, Škoda and Volkswagen now use dual-clutch transmission units that feature Sulzer synchronizer components. This demonstrates their belief in the quality of the products.

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Over 100 years ago

Steamers have been operating on Lake Lucerne in Switzerland since 1837. These elegant passenger ships with majestic paddle wheels connect the communities around the lake. The size of the vessels has continuously increased. In 1899, the shipping company began planning the construction of a new 59-meter steamer that could transport around 900 passengers at a speed of 26 km/h. The archives reveal that "apart from the price, the products offered by Sulzer are clearly superior to those of its competitors." After taking around 5 months to build, the "DS Uri" entered into service on May 8, 1901.



"The ship's compound engine with a condenser based on the Sulzer C.R.S.M. model is still largely in its original condition after sailing more than 2 million kilometers," states the ship's superintendent Roger Benz. "The boiler manufactured by Sulzer lasted 90 years and was only

replaced with a new installation in 1991." The compound engine, which is driven by superheated steam and consists of a high-pressure and a low-pressure cylinder, achieves around 650 HP at 48 min⁻¹ and uses 20 liters of diesel oil per kilometer.

50 years ago

The maiden voyage of the "MS Schwyz" on July 18, 1959, was another milestone. With its tall masts, funnel and wheel house, the ship resembles an ocean liner. It was fitted with a Sulzer engine, like many of the ships that crossed the oceans in those days. Both of its TW24 type 2-stroke diesel engines run at 400 min⁻¹ and each achieves 450 HP. They jointly consume around 5 liters of diesel per kilometer.

Today

Sulzer has not built any new diesel engines for 20 years. However, the legendary quality of its technology still remains today—as demonstrated by vessels such as the "MS Schwyz", which is still in daily operation after traveling a distance of 1.35 million kilometers over a period of 50 years. On July 18, 2009, the elegant vessel will celebrate its official birthday at 12.12 p.m. at Bridge 1 in Lucerne in the direction of Brunnen.

Beat Winterflood

