

## THE FUNCTION AND TYPES OF THE TRANSMISSION GEARBOX

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**Abstract:** The transmission gearbox is a crucial component of an automobile's powertrain system, responsible for transmitting power from the engine to the wheels while enabling the vehicle to operate at various speeds and torque levels. This article discusses the main functions of the transmission gearbox and classifies its common types, including manual, automatic, continuously variable (CVT), and dual-clutch transmissions (DCT). Understanding these types enhances knowledge of vehicle performance, fuel efficiency, and driving comfort.

**Keywords:** Transmission gearbox, powertrain, manual transmission, automatic transmission, continuously variable transmission (CVT), dual-clutch transmission (DCT), gear ratios, vehicle performance.

The transmission gearbox is a vital part of an automobile's drivetrain system. It plays a key role in controlling the power generated by the engine and transferring it to the wheels efficiently. By adjusting gear ratios, the transmission allows vehicles to operate smoothly under different speed and load conditions while optimizing fuel consumption and engine performance. Over the years, various types of transmission gearboxes have been developed to meet the demands of modern driving, comfort, and efficiency. This article aims to explain the fundamental functions of transmission gearboxes and describe the main types commonly used in the automotive industry.

The primary function of the transmission gearbox is to transfer power from the engine to the wheels while allowing the vehicle to operate efficiently across a range of speeds and torque demands. It adjusts the engine's output by changing gear ratios, which helps to:

- Increase torque for acceleration or climbing hills
- Reduce engine speed at higher vehicle speeds for fuel efficiency
- Provide smooth driving experience by enabling gradual power delivery
- Reverse the direction of the vehicle

The transmission also plays a critical role in protecting the engine and drivetrain components from excessive loads and mechanical stress.

Manual transmissions require the driver to manually select and engage gears using a clutch pedal and gear lever. This type is valued for its mechanical simplicity, fuel efficiency, and driver control over gear selection. It typically consists of a set of gears and synchronizers that allow smooth gear changes.

Automatic transmissions shift gears without driver intervention, using hydraulic systems, sensors, and electronic controls. This type offers ease of use and comfort,

especially in stop-and-go traffic. It generally uses a torque converter instead of a clutch to transfer power smoothly.

CVT uses a belt and pulley system to provide an infinite range of gear ratios, eliminating discrete gear steps. This results in smoother acceleration and better fuel economy. CVTs are common in compact and hybrid vehicles.

DCT combines features of manual and automatic transmissions by employing two separate clutches for odd and even gears. This design allows for very fast and seamless gear shifts, improving performance and fuel efficiency. It is often used in sports and luxury cars.

The transmission gearbox is an intricate mechanical system made up of several vital components that interact seamlessly to ensure efficient power transfer from the engine to the wheels. The main components include:

**Gears:** The core elements of the gearbox, gears of different sizes and tooth counts establish various gear ratios. These ratios allow adjustment between engine speed (RPM) and wheel speed, providing necessary torque multiplication or reduction depending on driving conditions. The gears can be spur, helical, planetary, or bevel, each type having distinct advantages in terms of strength, noise reduction, and efficiency.

**Shafts:** There are typically multiple shafts inside the gearbox, including the input shaft, countershaft (or layshaft), and output shaft. The input shaft connects directly to the engine's clutch or torque converter and transmits power into the gearbox. The countershaft holds the gears that mesh with the input and output shafts, enabling different gear ratios. The output shaft delivers the adjusted rotational force to the driveshaft and ultimately the wheels.

**Clutch (Manual Transmission):** The clutch is a friction-based device that engages or disengages the engine from the transmission, allowing the driver to change gears smoothly without damaging the gearbox. It plays a crucial role in starting and stopping the vehicle and in shifting gears.

**Synchronizers:** Present in manual gearboxes, synchronizers match the rotational speed of the gear to the shaft, ensuring smooth and noise-free gear engagement. This mechanism prevents gear clash and facilitates comfortable gear shifts.

**Torque Converter (Automatic Transmission):** Instead of a clutch, automatic transmissions use a torque converter, a type of fluid coupling device. It transmits and multiplies torque from the engine to the transmission input shaft using hydraulic fluid dynamics, enabling smooth acceleration from standstill and providing torque multiplication during low speeds.

**Hydraulic and Electronic Control Systems:** Automatic and modern manual transmissions employ hydraulic systems controlled by valves and pumps, along with electronic control units (ECU), to manage gear shifting based on parameters such as

vehicle speed, engine load, throttle position, and driver input. These systems optimize performance, fuel efficiency, and driving comfort.

Gear ratios represent the relationship between the number of teeth on two meshed gears or the speed of the input shaft relative to the output shaft. The choice of gear ratio directly impacts vehicle performance:

**Low Gears (First, Second):** Provide high torque multiplication, which is necessary for starting the vehicle from rest, climbing steep grades, or towing heavy loads. These gears reduce the speed but increase the torque delivered to the wheels.

**Higher Gears (Third, Fourth, Fifth, etc.):** Provide lower torque multiplication but higher speed ratios, suitable for cruising at highway speeds with lower engine RPMs. This reduces fuel consumption and engine wear.

**Reverse Gear:** Changes the direction of rotation, allowing the vehicle to move backward.

An efficiently designed transmission will have an optimal range of gear ratios to provide smooth acceleration, fuel economy, and adequate power under various driving conditions.

Electric vehicles (EVs) and hybrids introduce new challenges and opportunities for transmission design. Unlike internal combustion engines (ICE), electric motors can produce maximum torque instantly and maintain high torque over a wide RPM range, often making multi-speed transmissions unnecessary.

**Single-Speed Gearboxes:** Most EVs use a simple fixed-ratio gearbox, reducing mechanical complexity and improving reliability.

**Multi-Speed Transmissions:** Some high-performance EVs and hybrids use multi-speed gearboxes to optimize acceleration and efficiency at different speeds.

**Power-Split Transmissions:** Used in hybrid vehicles, these systems can combine power from the electric motor and the ICE seamlessly, allowing for efficient operation in various driving modes.

**Electronic Control Integration:** Advanced transmissions in EVs and hybrids rely heavily on software controls to manage power flow, regenerative braking, and seamless transitions between power sources.

The automotive industry is experiencing rapid technological advancement, which extends to transmission systems:

**Automated Manual Transmissions (AMT):** Combine the efficiency of manual gearboxes with automation for easier operation and improved fuel economy.

**Multi-Speed CVTs:** Innovations aim to extend CVT capabilities by adding discrete gear steps, improving responsiveness and durability.

**Integration with Autonomous Driving:** Transmissions are being optimized for driverless vehicles, where smooth, efficient, and predictive gear shifting is crucial.

Use of Lightweight and High-Strength Materials: Advanced alloys, composites, and coatings reduce weight while improving strength and heat resistance.

Electrification: As electric mobility grows, new transmission concepts tailored for electric drivetrains focus on maximizing efficiency and performance, including two-speed gearboxes for improved acceleration and range.

### **Conclusion**

The transmission gearbox is a fundamental component of any automobile, responsible for transferring power from the engine to the wheels while adapting the output to varying driving conditions. Its ability to modify torque and speed through different gear ratios ensures efficient vehicle operation, improved fuel economy, and enhanced driving comfort. Various types of transmissions—including manual, automatic, continuously variable (CVT), and dual-clutch (DCT)—offer unique advantages and are chosen based on the vehicle's purpose and driver preferences.

With ongoing advancements in automotive technology, transmissions are evolving rapidly to meet demands for higher performance, lower emissions, and integration with electric and hybrid drivetrains. Innovations such as automated manual systems, advanced electronic controls, and lightweight materials contribute to more efficient, reliable, and user-friendly transmission systems.

Understanding the functions, mechanisms, and types of transmission gearboxes is essential for engineers, mechanics, and drivers alike, as it supports better maintenance, repair, and optimal use of vehicles in diverse conditions. The future of transmission technology lies in further integration with electric mobility and autonomous systems, promising safer, cleaner, and more efficient transportation.

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