

MAHLE Powertrain Transmission Design & Development

Innovative Gear Development & Production

Specialist Testing of eMachines

Comprehensive Customer Support



MAHLE Powertrain Transmissions Design & Development

Vehicle transmission systems transfer rotary energy from the motive power source to the driven wheels, irrespective of how the energy is generated. Forward and reverse motion is also enabled by the transmission using additional gear sets whilst a clutch allows a smooth transition of power during pull-aways and also complete disengagement to allow engine idle when stationary. Automatic and 'double clutch' transmissions are now in widespread use allowing vehicle developers to control the engine speed and therefore the emissions and fuel economy more closely, and also providing a more comfortable driver experience.

Electric vehicles, or hybrids with pure electric drive, do not require such a wide range of fixed ratio gears within the transmission, as their electric traction motors are capable of a much greater range of operating speeds, but reduction gears are often still required to match optimum motor speed with road speed. Electric motors provide maximum torque output from zero which then gradually decreases with speed, so the transmission gears must be designed with this in mind.



>> Compact 4-Speed
Transmission

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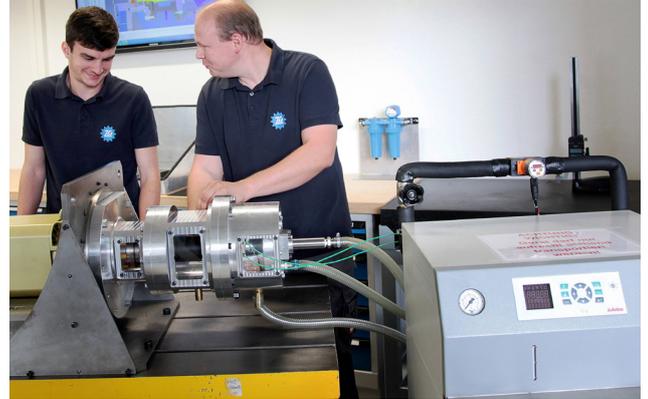
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Design Process & PlanGear software solution

The initial concept design for a new transmission system involves a complex, iterative process to establish the number of ratios required, the arrangement of the gear shafts, bearings and control elements, the maximum speeds and loads to be managed and the package constraints. MAHLE ZG Transmissions has developed very powerful 'PlanGear' software in-house which generates and evaluates all possible gear configurations to fulfil the required criteria. This fully-automated gear synthesis approach is applied for automatic, dual-clutch and hybrid gears consisting of any number of shafts, spur gear stages and planetary gear sets. The 'PlanGear' programme quickly provides output in the form of a visual display showing the gear mechanics, switching matrix, load capacity matrix and corresponding ranking to allow critical design decisions to be made at an early stage in the project.



>> Modular Test Rig



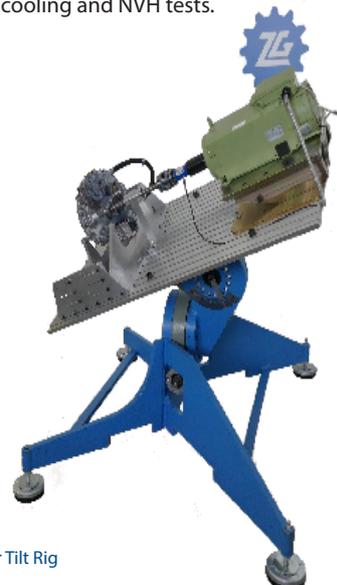
>> Axial Sealing Rig

PlanGear process

The detailed design process is based on the output from the 'PlanGear' programme which includes automatic dimensioning of the gears. A high resolution 3D CAD model is then created along with a complete set of drawings for all the gear components, shafts, bearings, switching elements and the housing. The model is then meshed into finite elements for stress, fatigue and NVH analysis. Once optimised, single or small batch quantities of prototype transmissions are manufactured in-house using a systematic documentation of all production stages. A wide spectrum of testing is then carried out on the prototype assemblies to validate all the required specifications including mechanical durability, lubrication, sealing, cooling and NVH tests.

Specialised Test Rigs

MAHLE ZG Transmissions has developed a range of bespoke test rigs to support the evaluation and development of transmissions and eMotors. Our specialist in-house equipment includes a tilt table for the simulation of g-loading during lubrication system optimisation and an axial sealing / rotor cooling rig for thermal and leakage testing of multiple seals (up to 10) simultaneously. Our modular test rig is used for experimental research on eMotors and clutch assemblies including oil and water cooling system development and thermal loss testing.



>> Motor Tilt Rig