

# Electric Planet Motor

Integrates gear and produces more power

Electric motors for industrial and automotive drives usually gain their high power density by means of a high rotational speed. In order to reduce this rotational speed, and – depending on the purpose of use – to increase the torque, all motors are equipped with gear units. The classic solution is to use the output shaft of the electric machine as input to a spur gear or a planetary gear. Thereby, the required rotational speed and torque are achieved. In doing so, motor and gear unit form two functionally and spatially separate components, which together form the most important part of the power train.

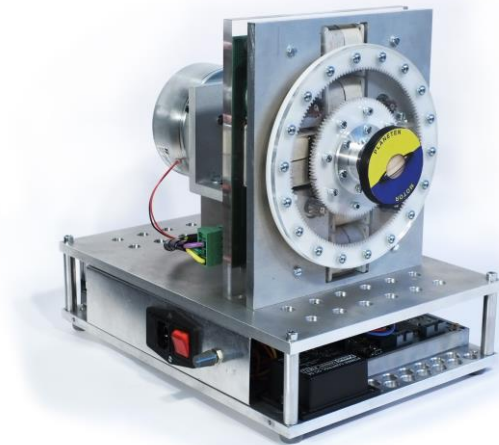
The rotor's rotational speed is limited by the strength properties of the rotor's material. Typically, peripheral velocities of 100-200 m/s can be achieved economically.

Cost-effective and weight-reducing alternatives to the two separate functional units, motor and gearbox, would be extremely useful for the establishment of electric drives for motor vehicles.

## Objective

Prof. Manfred Schrödl and his project group at the TU Wien aimed to develop a simplified yet particularly powerful motor-gear system. The focus was on finding a way to raise the performance limits of high speed engines, for example such as those required for e-mobility, by increasing the rotor speed, without raising the peripheral velocity.

Another objective was to unite the two separate functional units, gear box and electric machine. In order to do so, the gear function – preferably with reduction gear and simultaneous cost reduction of mechanical components – should ideally be integrated into the electric machine.



Ring gear and sun gear are mounted together - here with a transparent disc, in order to make the planetary gears visible

## Solution

The basic idea for the newly developed drive system is the division of the conventional rotor into several partial rotors. The motor will perform as a parallel system of several rotors, in which the entire motor winding can be reduced to half by skillful design. Thereby, copper and iron can be economized. The magnetization in the synchronous revolving rotors (pairwise in opposite directions) is preferably realized by means of permanent magnets. It is, however, also possible to design reluctance motors that function completely without rare earth metals.

When divided into four rotors, two rotors revolving into the same direction power a larger, inner-toothed gear (ring gear), while the two counter-revolving rotors power a smaller, externally-toothed gear (sun gear). These two gears and the four small gears of the rotors resemble a 'planetary gear', name giver for this motor.

Ring gear and sun gear rotate in the same direction and – given the appropriate dimensioning – with same angular velocity.

Hence, they can be permanently integrated, resulting in a strong output, while at the same time the strain on the individual rotor outputs is reduced.

In order to obtain an even more cost-effective system, the planet motor can be regulated until standstill without sensors. This can be realized by means of the INFORM® method, used successfully for years in tens of thousands of power units. This method enables the elimination of error-prone sensors and leads to a further reduction of volume as well as assembly or maintenance mistakes. Thereby, a highly dynamic, robust and cost-effective drive is being achieved.

## Results

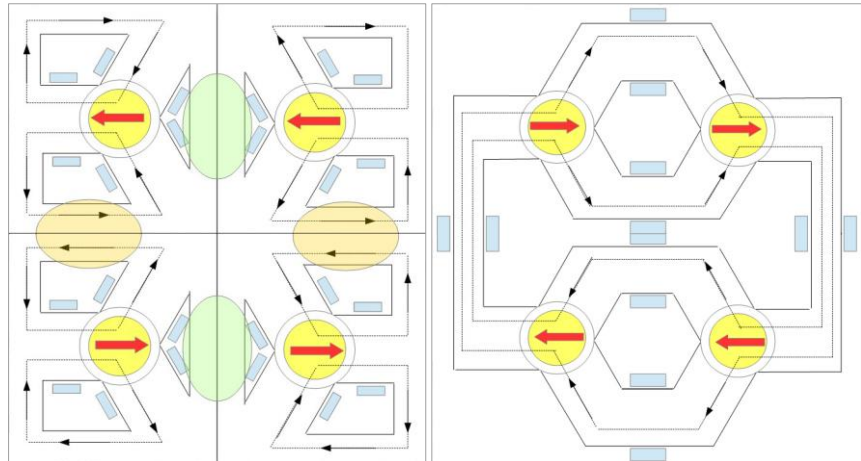
The gear unit becomes an integrated part of the output side of the motor.

The power electronics can be placed simply at the front side, opposite of the output side. Together with the configuration of the coils, this results in considerable advantages for automated manufacturing.

Measurement results on a prototype with an integrated 1:10 gear reduction show: the electrical behaviour at the terminals of the planet motor corresponds to a classic three-phase machine, controlled by a conventional inverter.

## Applications

- E-mobility
- Aerospace technology
- Construction machinery or heavy equipment
- Machine tools and production machines
- Emergency units of various sorts
- Drum drives
- Robot joint drives



Four motors of the same kind (left) -  
 Arrows in direction of the magnetic flux.  
 Brown: Magnetic field is being compensated. Green: No magnetic field.  
 Reduction of the structure leads to halving of number of required magnetic coils (right)

## Your benefits

- Compact power train based on integration of motor and gear unit
- higher power density: up to +50% at same volume
- with four rotors: double performance compared to conventional machines with the same rotational cross-sectional area
- failure safety due to elimination of sensors
- enhanced efficiency at lower production cost
- significantly higher load capacity at given form and material quality of gearing
- extremely flat design possible
- especially suitable for safety-critical or high-performance application
- manufacturing with a high degree of automatization possible

### Contact

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