



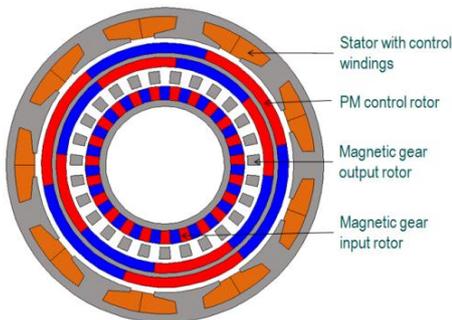
MAGSPLIT® Magnetic Power Split Device

Contactless, Lubricant-free Power Split Device

The MAGSPLIT® (magnetically Controlled Variable Transmission) is a highly efficient electrically controlled power split device that can achieve a continuous range of gear ratios to match a fixed speed prime-mover to a variable load.

It is an integration of a magnetic equivalent of a planetary gearbox with a high performance brushless PM motor/generator. The gear has no contacting parts and does not require lubrication. Variable speed mechanical output with a fixed input mechanical speed is achieved by exporting/importing electrical power through a set of control windings – splitting the power along a “variator” path.

MAGSPLIT is well suited to blended hybrid power trains.



MAGSPLIT® principle

With the outer PM control rotor held static the magnetic gear has an intrinsic fixed ratio gear. By controlling the current flow through the stator control windings the rotational speed of the PM control rotor is varied and hence the gear ratio can be controlled over a broad range about the intrinsic ratio. Through this speed control the MAGSPLIT is also capable of fully disconnecting the output drive.

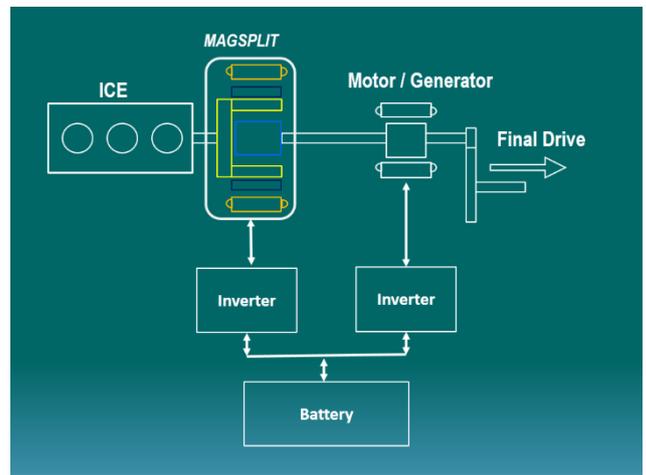
The gear ratio is controlled by varying the speed of the outer array of magnets which become the high speed element of the gear. This is much simpler than using a mechanical planetary system where the speed of the sun gear must be controlled.

MAGSPLIT® Key Benefits

- High efficiency operation over a broad range of speeds (no friction or pumping losses)
- Large degree of freedom in design through breadth of design factors (gear ratios, magnet shape and grade)
- Short and compact concentric package (Fully integrated gear and variator motor/generator)
- Power splitting – adjustable conversion of input power to output electrical and mechanical power
- In-built torsional compliance reduces drivetrain pulsations – remove flywheels and torsional dampers
- No lubrication oil or mechanical wear (low maintenance)
- Low noise and vibration
- High dynamic response

Typical System Architecture

In a typical installation the MAGSPLIT is mounted directly onto the crankcase of the internal combustion engine. The gear ratio and hence mechanical power delivered by the engine to the wheels is controlled by varying the electrical power flow through the motor/generator. This electrical energy is either transiently stored or directed back to the drive train via a second traction motor. This allows the engine to operate over a narrow speed band offering peak efficiency whilst delivering a variable speed drive to the wheels. It can fully disconnect the output drive (declutching operation) and provide sufficient torque to crank the engine. The inherent compliance of the magnetic gear removes engine torque pulsations, eliminating the flywheel and torsional damper arrangement, contributing to reduced system cost.

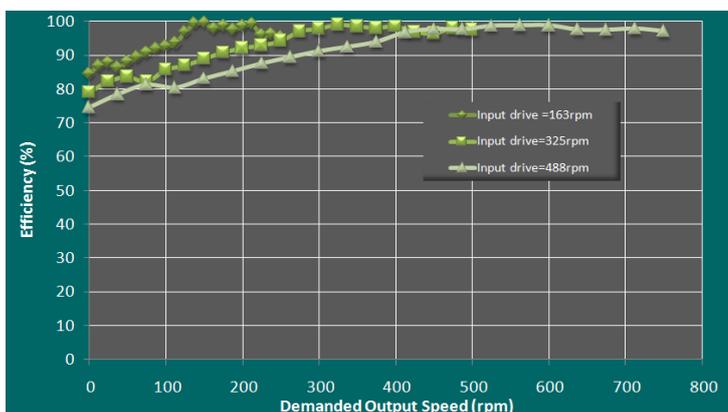


Typical Specifications

Specifications	mCVT10	mCVT20	mCVT100
Peak Torque	100Nm	230Nm	1,500Nm
Nominal Torque	80 Nm	200Nm	1,000Nm
Gear Range	De-clutch - 2:1	Reverse - 2.45:1	TBD
Diameter	250mm	340mm	460mm
Length	150mm	105mm	300mm

Applications

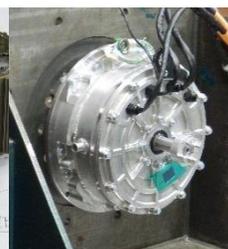
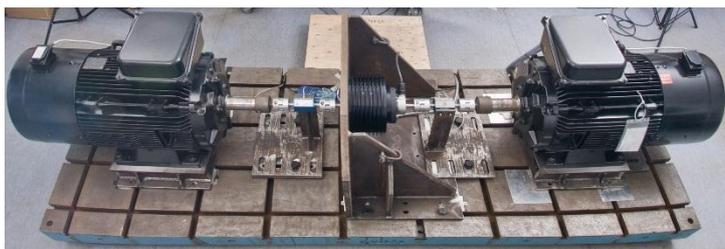
- Parallel Hybrid Electric Vehicles – matching engine speed to road loads to optimise engine efficiency
- Ancillary Drives – running pumps and compressors closer to optimum speed
- Wind Turbine – matching variable speed turbine blades to a fixed speed generator for simple grid connection
- Marine Propulsion Systems – matching engine speed to propeller speed



Efficiency

The magnetic gear within the MAGSPLIT has a typical efficiency of 99.5% at rated load. Losses are associated with importing/exporting power through the electrical path (i.e. winding copper losses). However, the total efficiency over a typical drive cycle is >95%.

It is also possible to optimise the MAGSPLIT to intrinsic gear ratios that are impossible with a mechanical gear. Often this makes to overall system efficiency higher.



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