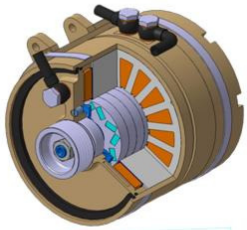
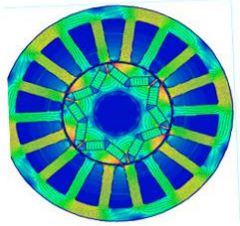
Press Release

New family of Internal Permanent Magnet e-machines for hybrid automotive applications

Integral Powertrain's hybrid systems group is pleased to announce the start of dynamometer validation testing of the first of a new family of advanced Internal Permanent Magnet (IPM) e-machines.



This latest IPM motor complements Integral Powertrain's existing Surface Permanent Magnet (SPM) family of e-machines which has now been proven at ratings from 5kW to over 100kW. The state of the art IPM design is intended for applications where high constant power speed range and minimum current requirements are paramount within hybrid motor applications. This makes the machines particularly suitable for integrated starter generator (ISG) systems, geared, high torque traction motors and power-split transmission applications.



The initial machine, the result of Integral Powertrain's scalable design and development processes, has been designed for a belt-integrated starter-generator (B-ISG) application and will operate in conjunction with Integral Powertrain's own VR-Pulley technology[1]. This system provides reliable, Stop-Start and regeneration functionality along with an electrical ancillary-drive mode.[1] http://www.integralp.com/vr-pulley.aspx

Technical Specification

Nominal Torque (Nm)	25
Nominal Power (kW)	9
Rated speed (Rev/min)	17,000
Overall Diameter (mm)	150
Weight (kg)	7.9

The stator design employs an 18-slot distributed winding and can be configured to run at nominal bus voltages between 14 and 800V. Integral Powertrain can also provide software and inverter hardware to support this range.

Streamlined Application

Integral Powertrain's Technical Director, Luke Barker comments, "We are committed to providing advanced and accessible e-motor technology for hybrid and electric motor powertrains. Our proven motor technology and architectures are matched to specific customer requirements using streamlined, knowledge based software developed in-house and in line with Integral Powertrain's existing Automated Intelligent Design (AID) systems."

* ***See IP's AID e-machine engineering system***

IP's permanent-magnet e-machine families

Integral Powertrain's latest addition complements the proven, high performance SPM architecture and allows coverage of a wide range of automotive applications:

6-pole / 9-slot concentrated-winding SPM family	6-pole / 18-slot distributed-winding IPM family
• Maximum Power and Torque Density • Up to 6kW, 6kW / kg	• High Constant Power Speed Ratio (CSPR) • Up to 200Nm/L
• Maximum Dynamic Response	• Minimum Phase Current Requirements
• Typical rated speed up to 20,000 rev/min, specialist applications at higher speeds available	• Typical rated speed up to 20,000 rev/min

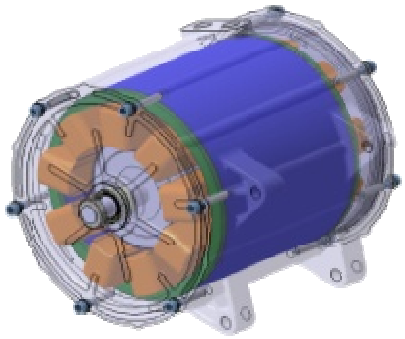
IP's AID E-machine Engineering System

A.I.D. is a proprietary Integral Powertrain advanced engineering system which enables complete customisation of IP's proven e-machine designs rapidly and to the highest possible quality level. The technology has been used successfully on a wide range of Powertrain engineering projects since 2003 with the e-machine modules developed in 2009.

The system is a comprehensive set of e-machine sub-system, design tools integrated directly into the CAD environment.

The A.I.D. for e-machines toolset functionality includes:

- Electromagnetic concept-level & FE analysis
- FE Stress analysis
- Mechanical analysis and bearing system selection
- Thermal analysis for transient & steady-state rating
- Controls simulation and inverter matching
- Bill-of-Material and cost analysis
- Supply-chain and manufacturing integration



A key advantage of A.I.D. is that the system provides a cohesive and proven framework on which product quality is continuously improved based on the experience gained with each application.

Company Summary

Integral Powertrain is a leading UK-based powertrain engineering consultancy, serving the global automotive and off-highway industries. It delivers engineering services for powertrain design and development, controls & emissions engineering, advanced engine R&D, and unique technologies innovation in the electric/hybrid and pressure-charging areas.

Since 1998 Integral Powertrain has successfully delivered over 40 major engine programmes to OEM's in Europe, North America, and Asia.

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