

100kW Brushless Permanent-Magnet Motor/Generator System

Project Objective

In 1996, DARPA requested white papers on a number of areas relating to electric and hybrid electric vehicles. In response to this request, UQM Technologies, Inc., submitted a white paper proposing the development of a large brushless permanent-magnet motor/generator system for use in large vehicles. At the time, such a product did not exist and it was seen that one would be needed as electric and hybrid-electric vehicle technology progressed.

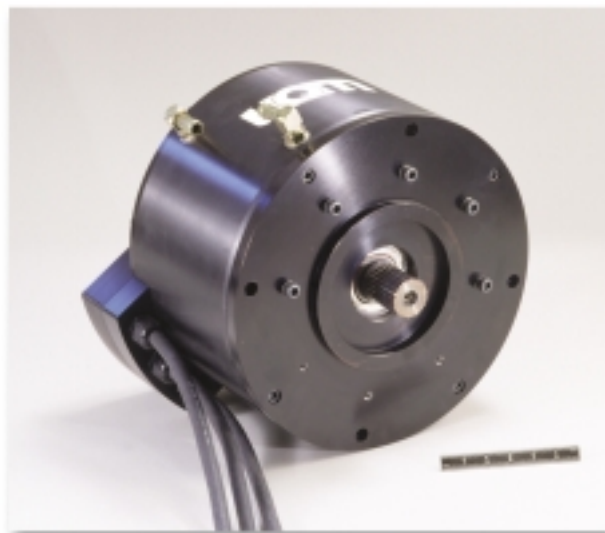


project overview

Due to experience in developing high efficiency, high performance, power dense motors and power electronic inverters for use in advanced vehicles, UQM was awarded a contract from DARPA and CTE to develop a large BPM motor/generator system. It was decided that the motor would be made large enough to propel a mid-sized bus. UQM studied the driving profiles and power requirements of typical 30'-35' buses and designed the motor around those specifications. This led to a power profile with a peak demand of 100kW, and a continuous output of around 50kW. In 1997 and 1998 the motor/generator system was developed with great success, and became UQM's PowerPhase 100 system.

Team Members

- UQM Technologies, Inc. (Formerly Unique Mobility)
- Center for Transportation and the Environment (CTE)



Project Results

The PowerPhase 100 Traction Drive system has become one of UQM's premier products. The motor, called the SR286, achieved a peak power output of 100kW, and a continuous power output of 55kW. It has a peak torque of 550Nm at low speeds, which is ideal for accelerating large vehicles from a zero speed. With all of this power, the motor weighs only 86kg and has a power density of 1160W/kg, much greater than a comparable AC Induction machine. With a diameter of less than 16" and a length of slightly over 14", the motor is also small enough to be used in a wheel hub configuration on large vehicles.

The Inverter/Controller, called the CD40-400L, is also quite advanced. Using a microprocessor and IGBT power devices, the CD40-400L incorporates serial and CAN communication, diagnostic capabilities, and four quadrant phase advance control. In addition, temperature sensing, speed sensing, and torque based traction control are all standard features of this inverter/controller. One big advantage to the PowerPhase 100 system is ability to switch between motoring mode and generation mode for regenerative braking in milliseconds. This allows large vehicles driven by the PowerPhase 100 to regain much of the energy typically lost in braking. This is especially useful in vehicles that do a lot of stopping in typical driving cycles, such as city buses. Combine these features with the fact that the PowerPhase 100 system has an efficiency greater than 90%, and it is clear why the product is such a success.

Since the development of the PowerPhase 100 system, it has been used in a number of applications. It is being used as both a motor and a generator on the hybrid-electric HMMWV, which has a fuel economy of 16mpg, twice that of the standard HMMWV. In addition, the vehicle accelerates from 0 to 50 mph in only 7 seconds – nearly one-half that of a standard HMMWV.

The PowerPhase 100 is also currently in use on several hybrid-electric buses produced by Advanced Vehicle Systems, Inc. These buses are in use in several cities in the US and they provide quiet, efficient transportation with a great savings in fuel economy over conventional buses.

Other applications utilizing the PowerPhase 100 include University vehicle projects such as the FutureTruck competition, and other proprietary commercial programs.

Next Steps

Today, there is continued commercial interest in the PowerPhase 100 system. The prospects of volume production are good, both from the hybrid-electric HMMWV and bus programs, as well as other proprietary applications.

With the experience gathered from using the PowerPhase 100 in a number of vehicles and environments, UQM is now going through a redesign in order to reduce the manufacturing cost of the motor and controller. When completed, the reduced price of the PowerPhase 100 system will allow it to be used in a greater number of vehicles and applications.

The specifications for the PowerPhase 100 system can be found on UQM's website at: <http://www.uqm.com>.

