



Pushing the Limit

How Racing the GVM Motor Optimizes a Production E-Bike

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Just about every car buff knows that innovations in automotive design often arise from the world of motorsports. It should be no surprise that the design of electric motorcycles benefits from a similar phenomenon.

[Parker](#) has been supplying the brushless permanent magnet (PMAC) motor from its GVM Series to power all-electric motorcycles made by Brammo (www.brammo.com). During the last few years, it has also sponsored the electric bike manufacturer in several races — most recently, in the all-electric FIM eRoadRacing series.



Racing pushes every component to the limit – electric motors are no exception. Over the years, Brammo pushed the custom GVM motor to its limits on the test track and in the races. This helped team engineers flush out weak points in the design to build a better production electric motor and a better e-bike.

Needless to say, designing the GVM motor was an iterative process. One goal was to get as much power as possible from as small a package as feasible to maximize the performance to weight ratio. A problem is that racing is an ideal world where teams often spare no expense. To keep costs down, Parker used standard GVM magnetics, although most other components were highly engineered and customized to reduce as much space and volume as possible.

During benchmark tests, team engineers tuned the motor/inverter for the specific track. Parker looked closely at performance parameters such as peak torque, rpm, battery usage, current draw, coolant temperatures, power output and lap times. Running the bike around the track dozens of times a day provided a lot of data to enter into analysis software so Parker could optimize the design on the next iteration.



For example, it boosted rpm for a large operating range and studied thermal limits both in the stator and rotor. Parker needed to ensure that in strenuous situations, the thermal aspects of the stator and rotor wouldn't damage those components, so it concentrated much of its efforts on cooling. As a result, the bike now features patent-pending technology, which comprises a low-loss electromagnetic design along with integrated cooling. Basically, the system gives the motor a higher power density than most other traction motors currently available due to the efficient packaging of the cooling system.

Parker also optimized torque-over-volume (in terms of the diameter and the length of the magnetics) as well as power-over-weight and power-over-volume. Here, the goal was to get a certain amount of torque independent of speed, which is part of the magnetics design, and to optimize those parameters, again with the use of analysis software.

In all, after meeting the required specs, Parker continually optimized the design in the software to do even more. Once satisfied, it took the best elements of the racing design and put it into a production-worthy mechanical package, which is designed to meet SAE J1455 for environmental standards.

Since Brammo started using Parker motors in 2011, the company has won the e-bike North American Championship every year and won the only World Championship in which the competed in 2012. What's more, Brammo is now using GVM standard magnetics in its own housing for the company's Empulse R production motorcycle. The TTX races were a great example of a high performance sport that pushes green and performance technology to the edge – and more.

Parker Hannifin will be exhibiting at Electric & Hybrid Vehicle Technology Expo, the only focused alternative powertrain exhibition in North America, taking place September 16-18, 2014, at the Suburban Collection Showplace, Novi, Michigan. Click [here](#) to register for your free exhibition hall visitor pass.

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