Design fax
Tech for OEM Design Engineers

Wheels:
Motorcycle race day shows off Parker's high-performance electric traction motor

By Jay Schultz, Product Manager, Electromechanical Automaton Division, Parker Hannifin

Sunday, July 25, 2010, was a big day for motorcycle racing enthusiasts around the world when a huge race event was held near Monterey, CA. Thousands of people came to the Mazda Raceway in Laguna Seca to see some of the world's best motorcycle racers compete in the Red Bull US Grand Prix on some of the world's fastest race bikes.

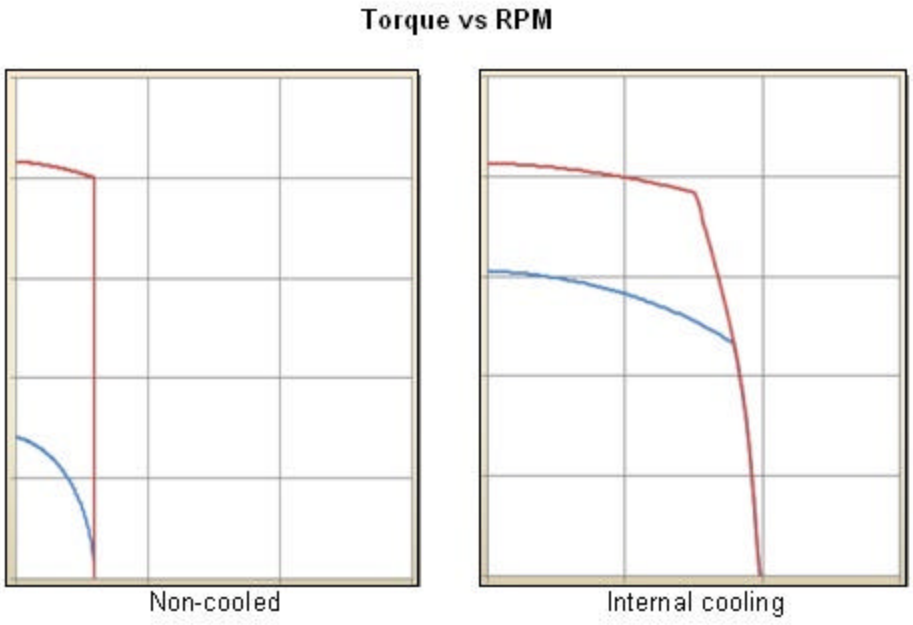
That was not the reason I pulled myself out of bed at 5:30 AM on that Sunday morning to make the 3-hour drive to Monterey. It was not to spend the day in the sunny California hills of the Monterey Peninsula or to visit its world famous aquarium. And, it most certainly wasn't to hear the deafening whine of the screaming cycles whiz by at 200 mph.

So what compelled me to surround myself in excessive bike noise, automobile traffic, crowds, and mid-day heat? The primary reason I drove to Mazda Raceway was, in fact, to NOT hear the deafening whine of the screaming cycles! That's right … I attended this race event to NOT deal with the noise (though I did have to put up with some while I waited with anticipation).

The "non-main event": a high-performance electric motorcycle race that promised crazy-fast speeds, professional bike racers, and near silence as these state-of-the-art race bikes passed by the spectators in a blur. Not only was the race itself fun to witness, but it also provided the perfect venue for Brammo, Inc. (Ashland, OR), to unveil its answer to high-performance electric bike racing — the all-new electric Empulse, which is a "scream machine" without the scream that features a Parker MPP traction motor that propels the bike silently at breakneck velocities.

This bike has been in development for several months. Competitors and enthusiasts were awed by the bike's look and feel as they walked through the paddock area and asked the Brammo engineers questions on the cycle's performance.

The MPP powering the bike features Parker's patent-pending dry-rotor internal cooling, a technology that increases the continuous torque output that drastically reduces the peak region of the motor. Below shows two speed-torque curves for the same motor: The first shows no cooling and the second only adds Parker's internal cooling. **RED = Peak; BLUE = Cont.**



This technology is particularly useful because very high-power output is required when accelerating out of each turn — and there are a lot of turns at Mazda Raceway. When the rider hits full throttle, the motor is sent into the "peak region." The driver does this with enough frequency rendering a non-liquid-cooled motor to very limited performance. In addition, the motor uses external cooling, allowing for very high motor speeds — up to four times the catalog rating. This combination of cooling and packaging gives the MPP traction motor on this bike a power density higher than that of most, if not all, traction motors available today. Coupling the cooling technology with an innovative winding design yields much higher torque per unit size than conventionally constructed permanent magnet motors and creates the core for our standard product line that can deliver 20 kW to 350 kW of power output with 95% efficiency.

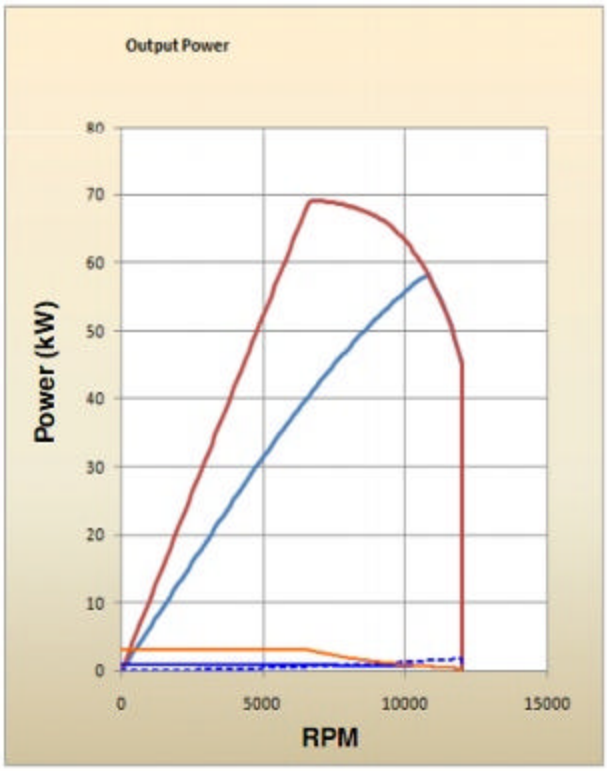
"Wow!" (If I do say so myself.)

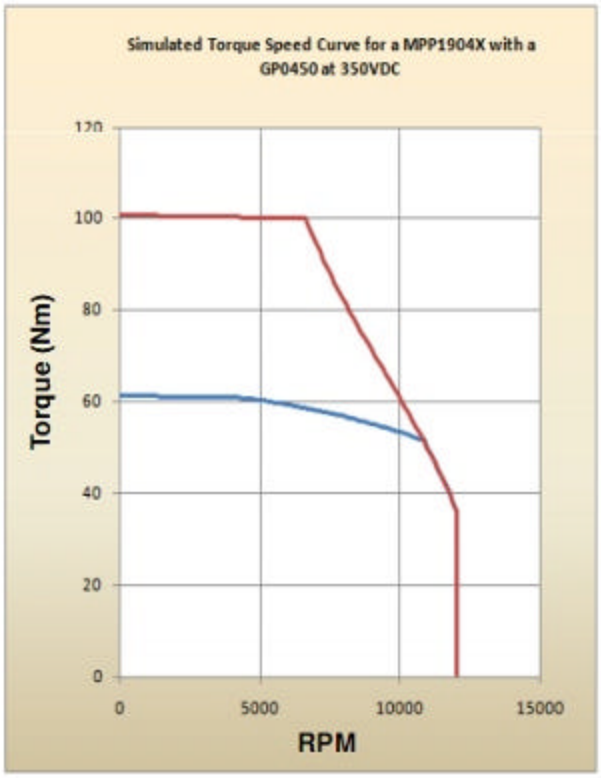
The bike wasn't quite ready for competition at this event. It is scheduled to make its official debut in September. [Note: Brammo also plans to market a street version of the race bike for the commercial market next year, also called the Empulse. Brammo and Parker are working through the details around a smaller MPP traction motor for the production version.] But even without the Brammo bike in the race, the other electric bikes competing were very exciting to watch. It was also rewarding to hear the spectators comment in amazement as the e-bikes accelerated to their top speeds but produced only a fraction of the noise of their ICE counterparts' output.

Now, I eagerly anticipate the next event in the e-Power racing series to be held in France next month. To further my energy for the event, the Brammo engineering team's evaluation of the race and winners a few weekends ago gave us all great confidence that the Brammo bike will be a strong contender for the winning trophy. France, here comes the MPP!

For the design engineers out there, I thought I would take a minute to highlight some more of the MPP motor specs. The motor used in the Brammo bike is proprietary and the data can't be published. But let's look at a typical MPP1904 PMAC traction motor controlled by a Parker SSD traction inverter. The output of the inverter is 225 Arms continuous and 450 Arms peak at a bus voltage of 350 VDC. Cooling temperature is assumed to be 50C @ 8L/min.

The following charts represent the performance for this motor. Any customer can order what is shown below. **RED = Peak; BLUE = Cont.**





Notice that there is roughly a 17% difference between the peak and continuous output power. The ability for the Parker motor to accomplish this is through our proprietary dual-cooling configuration

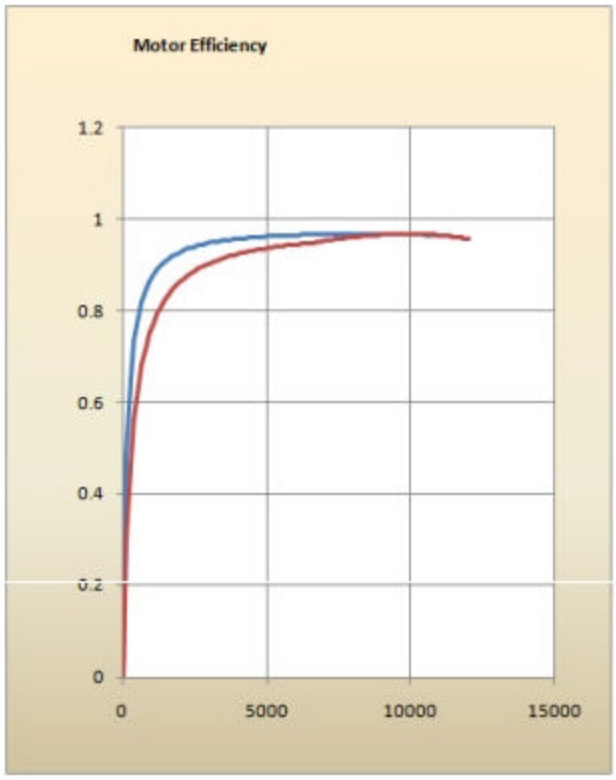
that I mentioned earlier. The efficiency with which we are able to expel heat generated within the motor gives the Parker MPP Traction motor an edge.

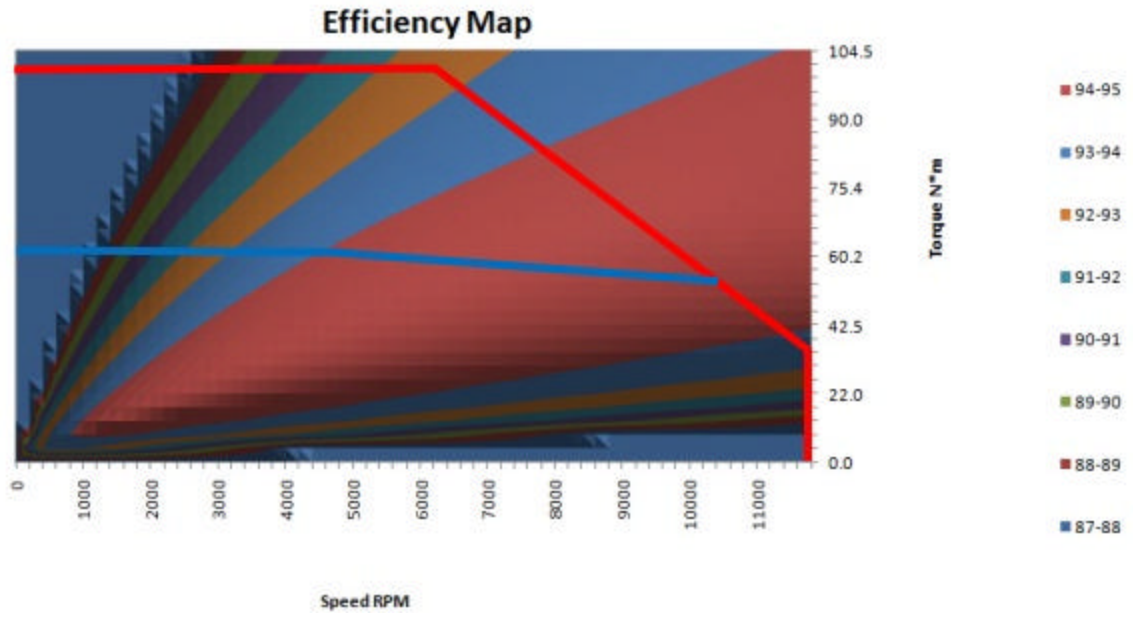
Data sheets, specs, and performance

The data below for the MPP1904X is generated from our proprietary motor software. It models the performance and specifications for our traction motors based on data from empirically tested motors. Parker's production-oriented design allows these data to be tailored to each customer's performance requirements. Often, base speed, supply voltage, current limits, and other criteria change from application to application. The flexible nature in which we manufacture these off-the-shelf traction motors allows us to optimize the motor's performance per the customer's desired battery pack.

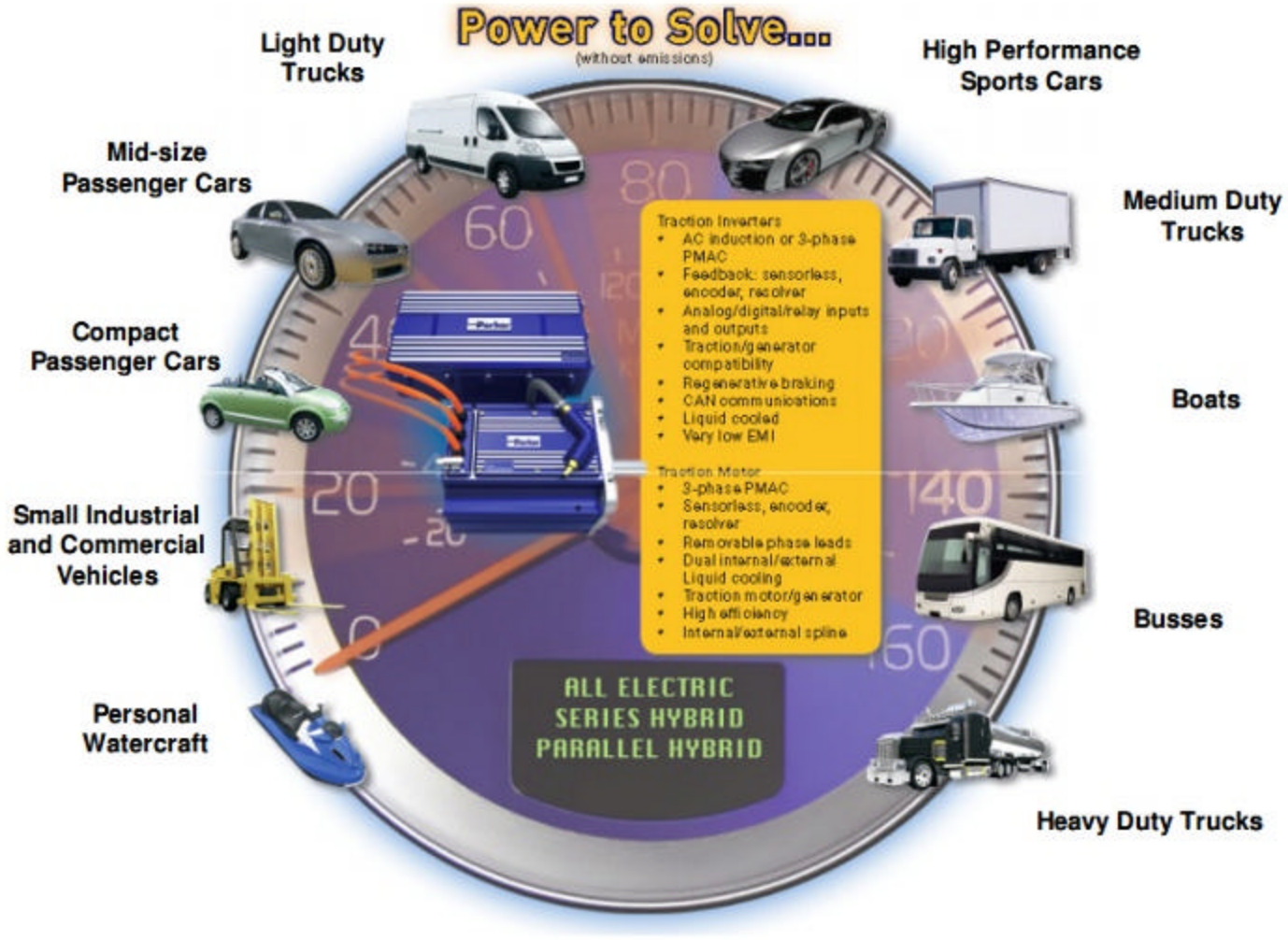
Combined Motor and Amplifier Specification Sheet			
Motor Model Number	MPP1904X		
Amplifier Model Number	GP0450		
Motor Thermal Test Condition	Internal and External Water Cooling		
Description	**Symbol**	**Units**	**Value**
Stall Torque Continuous	Tcs	Nm	61
Stall Current Continuous	Ics(rms)	Arms	225
Peak Torque	Tpk	Nm	101
Peak Current	Ipk(rms)	Arms	425
Base Speed	Sr	rpm	10813
Max Speed	Sm	rpm	11800
Rated Shaft Output Power	Pout	kW	58
Current at Rated Speed	Ir	Arms	188
Operating Voltage	Vnbus	VDCnom	350
Max DC bus Voltage	Vmbus	VDCmax	750
Max Winding Temp	Tmax	°C	155
Motor Weight	weight	kg	26
Amplifier Bus Voltage	Volts DC		350
Amplifier Continuous Current	Ica(rms)		225
Amplifier Peak Current	Ipa(rms)		425
Amplifier Switching Frequency	kHz		4

The next two charts represent two different views of the efficiency output for the motor. These are supplied to the customer so they can model the performance of their vehicles at any operating point — very important aspect when considering range of the vehicle.





Lastly, I wanted to present some examples of other applications for Parker traction motors. The following image depicts the vehicle platforms Parker is CURRENTLY solving with our MPP traction motor technology. In many of these categories, we are working on multiple programs.



The MPP Traction motor is being used as the exclusive motor providing torque to the wheels (or props) on these vehicles. The motors are also used as generators coupled to a smaller engine to provide extended range. In parallel systems, they rest between the engine and the transmission. Finally, they are used to power hydraulic systems in “light” hybrid applications. MPP Traction motors range in output from 20 kW to 350 kW. We also have the “non-traction” versions powering power steering and braking systems on electric vehicles.

What is not shown on this graphic is off-road construction vehicles. We have many applications solving various hybrid projects with many of the leading manufacturers of heavy equipment.

Of course, if you have any questions about Parker’s electric traction motors you can feel free to email me at: JSchultz@parker.com.

You can also read more about the Empulse bike's debut, its performance characteristics, and the new line's plans for the future here in a great online article from MotorcycleUSA.com: http://www.motorcycle-usa.com/750/7468/Motorcycle-Article/Brammo-Empulse-Electric-Motorcycle.aspx.