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## *HEV Systems Technical eNewsletter*

Happy New Year! We have expanded our Complimentary Webinar offerings to include practical applications for learning HEV Systems technology. We will soon be covering **re-conditioned components** and **Hybrid service opportunities**. Be sure to sign up for these webinars in our [webinar catalog](#)!

PS- Did you join us for Parts 1 & 2 of *Diagnosing Hybrid Vehicle Electric Machine (Transmission) Failures*? Click on the Register Now button to join us for the third (and final) segment of the series! If you would like a link to review a recording of parts 1 & 2, please email Ariel, our webinar moderator at [ariel@go2hev.com](mailto:ariel@go2hev.com).

### ***Voltage, Horsepower & Torque: It's All About Relationships!***

As hybrid and electric vehicles continue to penetrate the traditional vehicle market the voltage level of the high voltage battery system continues to increase. As an example, a 2003 Honda Civic contains a **144 volt** battery system in contrast to a 2011 Chevrolet Volt with a battery system nearly **400 volts**. There are important reasons that automotive manufacturers continually entertain increasing system voltage levels. One of the primary reasons of why increasing the system voltage level is fundamental to developing an electric propulsion system is that the voltage level is directly linked in determining horsepower (hp), torque, and speed (rpm) of electric machines that propel the vehicle. Moreover, system voltage is the basis for determining the relationship of hp, torque, and speed.

To begin assessing the relationships of voltage, hp, torque, and rpm the system electrical power must be calculated to determine the hp. Therefore, the Wattage and Power Law equations must be used as a tool to assist in determining hp:

1. **Determine horsepower (hp):**  $746 \text{ Watts (W)} = 1 \text{ hp}$

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**Register  
Now**

*Diagnosing Hybrid Vehicle  
Electric Machine  
(Transmission) Failures (Part  
of 3-Part Series)*

Our next Complimentary Webinar is on JANUARY 18<sup>th</sup> 2012. Click on the button above to register!

Did you miss this series? We will be re-running all three parts again later in Spring 2012. Click on the webinar catalog above to register!

Watts (W) = (hp) (746)

Example: 14,920 Watts = 20 hp

## 2. Determine high voltage system Power in Watts ( $P_W$ ):

Electrical Power (Watts) = (Voltage) (Amps) or  $P_W = (V) (A)$

Example: (400 Volts) (400 Amps) = 160,000 Watts of Power

## 3. Determine hp by using Watts of electrical power:

$$\text{hp} = \frac{\text{Watts}}{746} \longrightarrow 214.447 \text{ hp} = \frac{160,000 \text{ Watts}}{746}$$

The calculations indicate that, if maximum battery system voltage were increased or decreased, the hp would also increase or decrease. Also, if the maximum amperage were increased or decreased the hp would also be affected. However, the amperage is always kept at the lowest possible level by engineers to decrease the size of components, cable/wire, decrease component temperature, etc. This will ensure a lower cost system and permit packaging of the components. Therefore, voltage becomes the vital element to the determining system Power (Watts) and hp.

Once the hp is known, the torque and rpm elements can be determined/selected by using simple equations (*note that the 5252 is a mathematical constant and does not change*).

$$\text{hp} = \frac{(\text{Torque})(\text{rpm})}{5252}$$

$$\text{rpm} = \frac{(\text{hp})(5252)}{\text{Torque}}$$

$$\text{Torque} = \frac{(\text{hp})(5252)}{\text{rpm}}$$

By reviewing these (linear) equations it can be seen that changing hp, rpm, or torque will effect/change the result.

In summary, if voltage increases hp, torque, and rpm will also increase. Therefore, since hp is a derivative of the vehicle system maximum voltage (and amperage) utilizing the highest voltage level in an electric traction system is one of the key elements in determining its overall performance. Also, knowing this information is vitally important if you or your organization is planning to build a project vehicle and needs to specify hp, torque, and rpm requirements. These concepts are also important to students who are beginning their study of electric propulsion systems. Relationships of hp, rpm, Torque, as they relate to voltage, are an important step in studying these systems.

**Next Month: Power Inverters 101**



Calling all technicians! Who will you be on March 12-16, 2012? If you answered, "At Goodyear Tire and Service Academy in Orlando, Florida you are right!

Hosted by Napa Autotech with sponsorship and training by AR&D, technicians can take a 5-day HEV Systems training course. Click on the thumbnail above for details, pricing, and special Disney packages for participants and their families!

The class is limited to only 20 PARTICIPANTS! [Pre-registration](#) is now open.

[Can't make it to Orlando? Click here to look at our other On-Ground training opportunities in 2012!](#)

AR&D has two satellite schools with whom we schedule HEV TTT courses to support summer availability.

Until next time remember - knowledge is **POWER**



*AR&D Tech Team*

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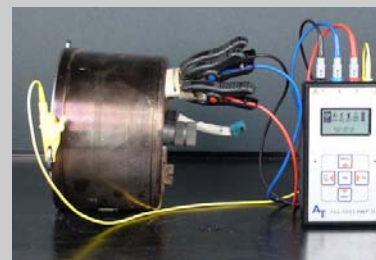


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We are also have affiliation  
with various venues to provi  
HEV Systems Training



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