

# Re: Understanding PWM of Motor (current problem)

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  - *Date:* Sun, 21 Dec 2008 10:25:35 -0800
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On Tue, 16 Dec 2008 22:38:56 -0600, "amdx" <[amdx@xxxxxxxx](mailto:amdx@xxxxxxxx)> wrote:

"Bob Eld" <[nsmontassoc@xxxxxxxx](mailto:nsmontassoc@xxxxxxxx)> wrote in message  
[news:sY\\_11.10801\\$c45.7345@xxxxxxxxxxxxxxxxxxxxxxxxxxxx](mailto:news:sY_11.10801$c45.7345@xxxxxxxxxxxxxxxxxxxxxxxxxxxx)

"amdx" <[amdx@xxxxxxxx](mailto:amdx@xxxxxxxx)> wrote in message  
[news:cc1fc\\$49484a7a\\$18d6b40c\\$5340@xxxxxxxxxxxxxxxx](mailto:news:cc1fc$49484a7a$18d6b40c$5340@xxxxxxxxxxxxxxxx)

Hi All,  
I've been having a discussion about PWM of DC motors on an electric vehicle forum.  
I keep seeing the idea that battery current is different than motor

current

when using a PWM controller. As quoted below.

<http://www.4qdttec.com/pwm-01.html> This site says this;  
"You should see from the above that, if the drive MOSFET is on for a 50% duty cycle, motor voltage is 50% of battery voltage and, because battery current only flows when the MOSFET is on, battery current is only flowing for 50% of the time so the average battery current is only 50% of the

motor

current! "

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I understand that 50% duty cycle would cause a motor voltage equivalent to 50% of the B+. And full current would flow for 50% of the time (ignoring inductance

caused

rise and fall time).

Quote;

"so the average battery current is only 50% of the motor current!"

But where are they getting the other 50% of the current? If you say it is from the collapsing magnetic field of the field and armature, then I would say, but the battery had to build that field to begin with so battery current during the 50% on time was had to be higher than the full cycle motor current.

Ok, I'm going to stop now, because I'm not sure I communicating!

This site has waveforms in Section #12 although my thought is he has the 500hz and 20khz labels reversed.  
[http://www.picotech.com/applications/pwm\\_drivers/#chap12](http://www.picotech.com/applications/pwm_drivers/#chap12)

Your help appreciated, Mike

Your on the right track. Fifty percent duty cycle means the voltage is 50% and also the average current is 50% as you mentioned. So, the power is 1/4 or 25%. That is to say both the motor speed and the motor torque are reduced by 1/2.

Ok so far.

It's wrong to say that the motor current is 50% of the battery current. The average currents of the battery and the motor are the same.

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That is what I think, the waveform may be different but the average or effective value is the same. But the EVers are saying if you use two shunts, one to measure battery current and one to measure motor current the numbers will be quite different.

No current is gained or lost .

That's what I think.

Now how do you explain what Mark had to say?

"i think that part you are missing is the CATCH DIODE. When the switch switches off, the current continues to flow through the diode. So with the right inductance, and a 50% DF, the current in the load flows all the time, the current through the battery flows 1/2 time so the average output current is 2x the input current and the output voltage is 1/2 the input voltage. Input power = output power. This is simplified and ignores losses of course."

I can't make this work, but I see others give the same logic.

Still searching, Mike

The one good concept presented here is that battery power  $\approx$  motor power.

Keeping that in mind; motor current is proportional to torque, and motor CEMF is proportional to motor speed. Net motor voltage is effective applied voltage (battery voltage \* DF) – CEMF.

Vehicle friction losses are minor except at very low speed, typically drag dominates. Drag has  $v^2$ ,  $v^3$ , and  $v^4$  components, with the higher powers becoming dominant at higher speeds. Remember that power  $\approx$  torque \* speed.

Since real vehicles operating at lower effective voltage also means operating at a lower speed. And none of it is very linear, thanks to drag.

Operating at steady speeds, the power required goes up by a curve

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similar to an exponential. (In the general case, in specially designed vehicles there are speeds with atypical drag minimums.)

So at rated max speed (max power) we have effective full voltage and full current and all the power is being eaten up fighting drag.

A 1/4 decrease in power should translate to about 78% of top speed, 86% voltage and 88% current and at full battery voltage 75% current.

A 1/2 decrease in power should translate to about 60% of top speed, 70% voltage and 73% current and at full battery voltage 50% current.

More decreases result in similar arithmetic.

HTH

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