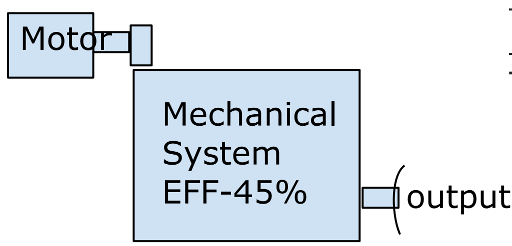
Defining Brushless DC Motors Blog #4:
An Example

By John Knott, President of JD Technologies, LLC

In my first three blogs I presented an overview of a simple six-step procedure for defining a permanent magnet BDCM and showed how to establish the relationship between motor sensitivity (Kt) and back emf (Kb), how to define the relationships between the motor constants and then derive the actual motor constants. In this, my 4th and final blog in the series I will give a specific example.



REQUIREMENTS:
_____V1= 230 v
Torque rate: (at output)
3000 in-1lbfstall torque
2000 in-1lbf@ 150/sec.
NO LOAD RATE of 250/sec.

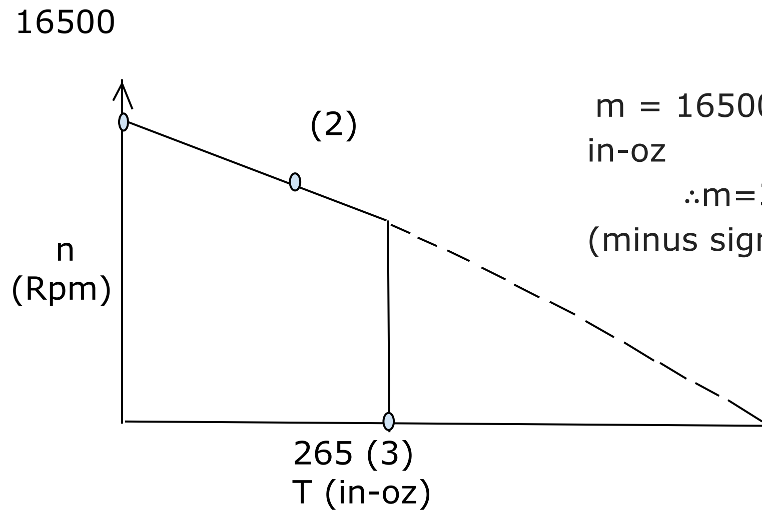
Efficiency = 45% includes the motor efficiency of 85%
Also GR = 397

Knowing the efficiencies and gear down ratio of the mechanical system, one can determine the torque and speed requirements of the motor:

MOTOR TORQUE MOTOR SPEED

(1) 265 in-oz	0 Rpm
(2) 177 in-oz	9925 Rpm
(3) 0 in-oz	16500 Rpm

from this m is determined:



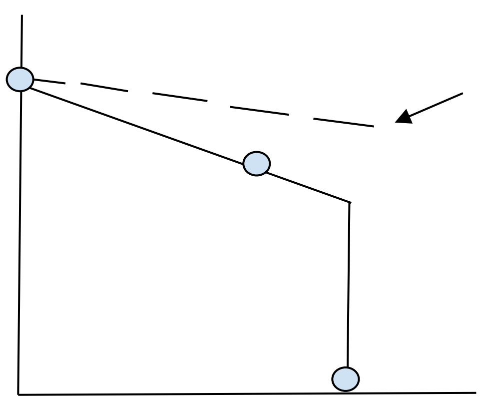
m = 16500 - 9925 Rpm0-177 in-oz

∴m=37.15 Rpmin-oz

(minus sign included in EQU (14)

*Line (1) - (2) is cut off at this point due to a current line limit. If the limit was not there the line would extent straight to the torque axis (depicted by the dotted line).

m = 37.15 Rpm/in-oz is the max requirement the motor manufacturer can take the liberty to decrease m:



dec m -- inc speed: i.e. the motor will be rated at a relatively higher speed.

EQU (23) will give us the back emf constant:

$$K_b = \frac{V_L}{N_n 1} = \frac{230}{16.5} = 13.94 \ \frac{volts}{100\ Rpm}$$

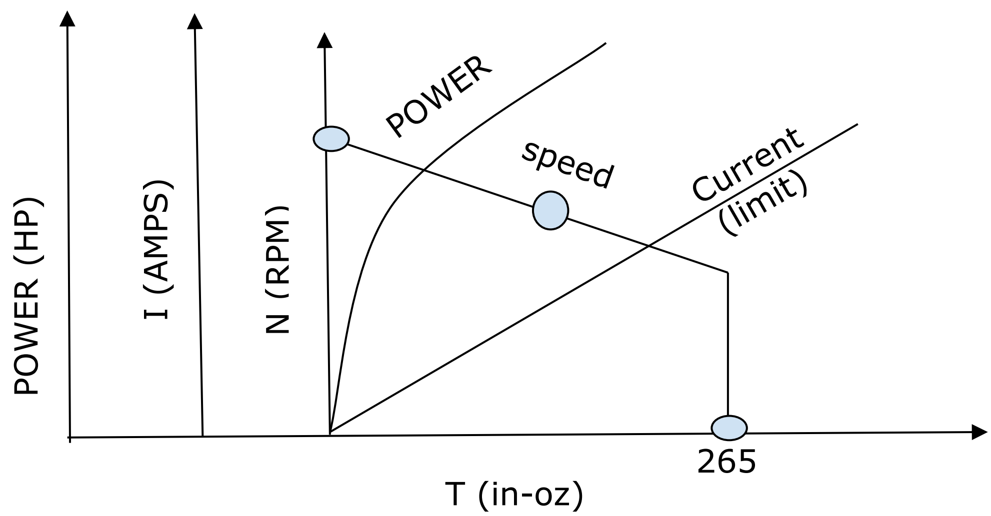
∴ from EQU (10) the motor sensitivity is:

K_t= 1.352 K_b= 18.85 $\frac{in-oz}{amp}$

K_t= $\frac{R}{K_b m}$= $\frac{R}{.01394(37.15)}$= 18.85

∴ R = 9.76Ω

Therefore, we now have our motor defined, <u>theoretically</u>:



$$K_t = 18.85 \frac{in - oz}{amp}$$
$$K_b = 13.94 \frac{volts}{100\ Rpm}$$
$$R = 9.76\Omega$$

At this point one should create a spec after consulting with a motor manufacturer, since *R* is <u>physically</u> limited.

This was done with Composite Motors, Inc. They responded with a motor defined in figure 1 ($R = 7.8\Omega$) which meets all our requirements:

Note: Since *R* was decreased from 9.6Ω, m was reduced.

recall $$K_t = \frac{R}{K_b m}$$ EQU (22)

$$\therefore \; 18.85 = (71.79)\, R/m$$

for $R = 7.8$ $m = 29.71 \frac{Rpm}{in{-}oz}$

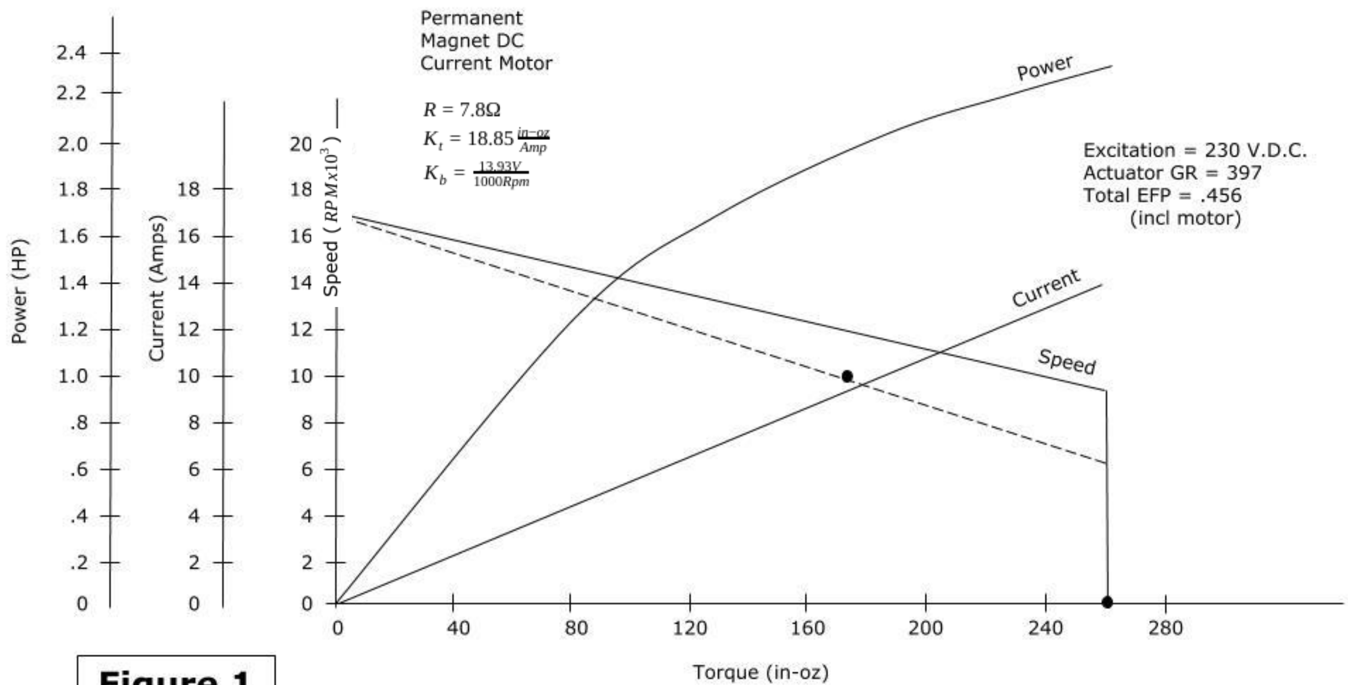


Figure 1

Beware of high I^2R losses (high heat loss) i.e., know your duty cycle. The duty cycle in this example is such that 7.8Ω is not a problem.

More to come

I hope you enjoyed our blog series, more importantly I hope you found it beneficial. The “more to come” is using this knowledge to define your motor and to be able to speak with more confidence when dealing with motor experts like Composite Motors, Inc.

Let’s Talk

I am confident that Composite Motors, Inc. with their Team and resources would be an essential foundation for supporting your BDCM development. All of Composite Motors, Inc.'s products are made on American soil. Let’s talk! Email me at johnk@jdtechsales.com or call me at 781-864-2220 or visit Composite Motors, Inc.'s website at www.compositemotors.com

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